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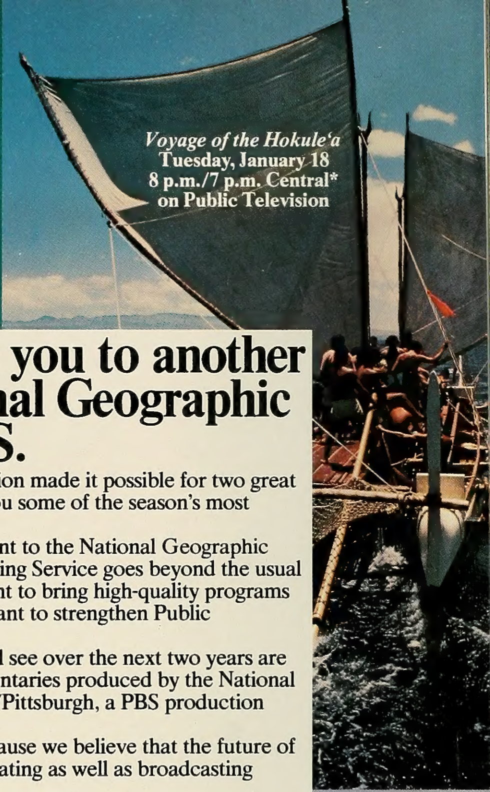

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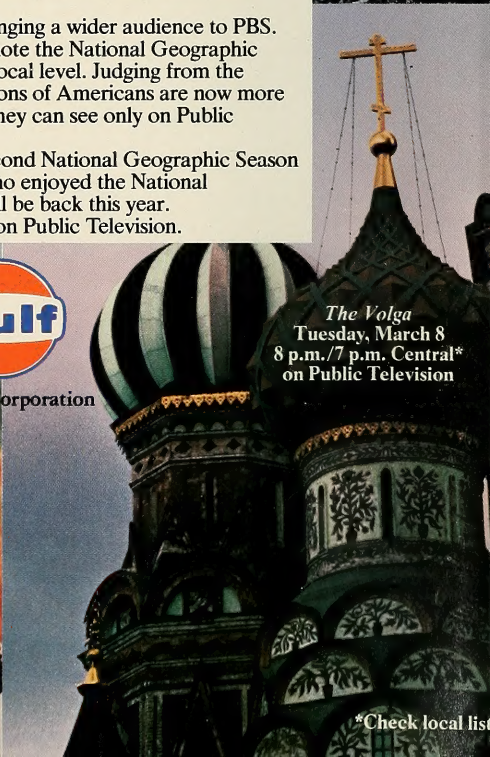

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January 1977

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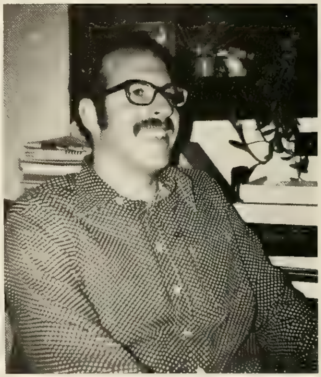

The idea for a second look
Mount Rushmore Memorial in Sou
Dakota came to **Mark D. Cobu**
when he was teaching a course on h
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tudes toward the landscape. A pictu
postcard of the Memorial sent by
friend did the rest. Assistant profe
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Durango, Colorado, Coburn receiv
his doctorate in English and the h
manities from Stanford Universit
He is a renegade New Yorker w
enjoys living amid Colorado's S
Juan Mountains and fervently hop
that no one will ever try to impro
them by adding eyebrows.

Finding that the slow loris has
very low body temperature and me
bolic rate, **G. Causey Whittow** u
dertook an investigation of the phys
ological mechanisms that would a
count for these phenomena. Th
work, which began while he w
serving as a visiting professor at t
University of Malaya in 1974, l
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ness of being a slow mammal. A pr
fessor of physiology in the School
Medicine at the University of Hawa
Whittow is now researching the the
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seal. Similar work on the Californ
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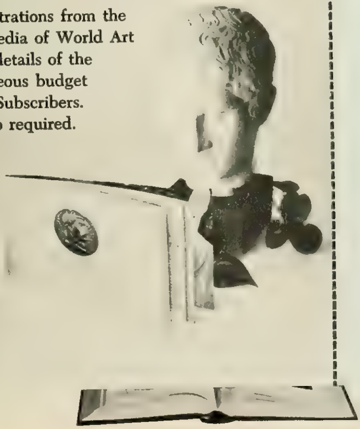

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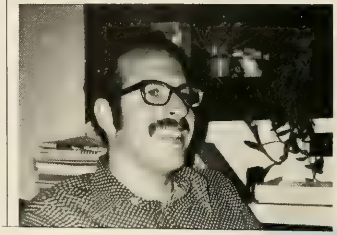

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Volcanoes and the Climate

by Owen B. Toon and James B. Pollack

Dust particles and sulfur gases ejected into the stratosphere by volcanic explosions cause changes in temperature as well as gaudy sunrises and sunsets

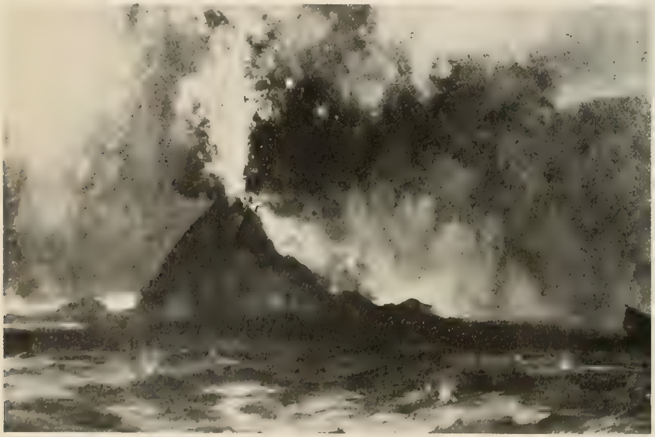
During April 1815, twelve thousand people in the Dutch East Indies died when the Tambora volcano spewed hot stones and volcanic ash into the sky in the most violent volcanic explosion of recorded history. Halfway around the globe and one year later, record low summer temperatures led New England farmers to name the year 1816, "Eighteen hundred and froze to death." Throughout the summer of that year, cold waves, snow, and frost killed crops. The price of corn and wheat shot up, and farmers were forced to sell their livestock at a loss. Many people were so discouraged that they left New England for the less-developed but warmer lands of the South and West. In Europe, 1816 was also a "year without summer." Crops failed to ripen and famine struck Britain, France, and Germany.

Some consequences of the bad weather of 1816 are still with us today. Mary Wollstonecraft Godwin, soon to become Mary Shelley, spent her vacation that dreary summer huddled near a fireplace reading ghost stories with her poet friends Shelley and Lord Byron. A story-writing contest developed and Mary wrote *Frankenstein,* which was published two years later. So, out of the rain and cold, a monster was born.

Did the Tambora eruption of 1815 cause the bad weather of 1816? Do volcanic eruptions in general cause changes in weather and climate? These questions are receiving increased attention today as meteorologists and climatologists try to understand why the climate changes, so that future variations may be predicted or avoided.

Benjamin Franklin was the first scientist to wonder publicly if volcanic explosions affect weather. He noted that a "permanent dry fog," perhaps originating from the smoke of volcanic eruptions in Iceland, covere North America and Europe during th summer of 1783. The fog seemed t dim the sun's rays, and Franklin believed that the solar heating lost tha summer was responsible for the severely cold winter of 1783/84. Franklin advocated that a thorough study b made to see if other years with summer "fogs" had unusually hars winters. The eminent contemporar British climatologist H. H. Lamb ha recently completed such a study. Hi work shows that weather worldwide—or at least in the hemispher of an eruption—*is* affected by volcanic explosions and that the first on or two years following major volcanic explosions are slightly coole than normal.

In Franklin's time it was believe that local weather, variable from yea to year, continually repeated itsel over long intervals of time. Today w know that the climate—the averag weather over a period of man years—is itself changeable. Twent thousand years ago the earth had glacial climate. A mile-high sheet o



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The eruption in 1883 of Krakatoa, an island between Java and Sumatra, is represented in an artist's rendition. The explosion, which was heard 2,000 miles away in Australia, almost destroyed the island. It propelled clouds of ash to a height of thirty miles, plunging the region surrounding the island into darkness for two and a half days, and triggered tidal waves that killed about 36,000 persons. The volcanic ash drifted around the globe for several years, causing spectacular red sunsets.

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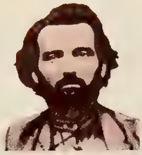

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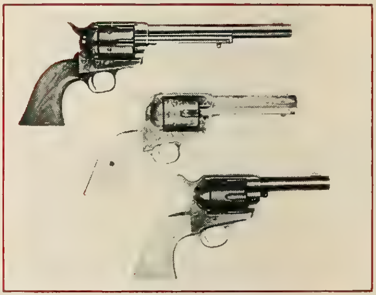

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ice then stretched across North America from the Atlantic to the Rockies and from the Arctic to the northern United States. Climate has also varied during the past few centuries. From 1500 to 1900, the earth's average temperature was slightly lower than it is now and small villages in the mountains of Europe were overrun by glaciers. From 1600 to 1700, polar sea ice was so extensive that no European ships could reach Greenland, which had been colonized centuries before.

Most meteorologists and climatologists today believe that a large volcanic explosion can cause bad weather, but they are skeptical about any relationship between volcanic explosions and changes in climate. A single volcanic eruption only affects the weather for a few years. If climatic changes do, in fact, result from volcanic explosions, large eruptions would have to occur every few years. We live in a period of very few large volcanic explosions. The eruption in 1912 of Mount Katmai in Alaska was the next to last. The only major eruption anywhere in the world since then was that of Mount Agung in Bali in 1963, so it is not possible to determine directly if climatic changes are caused by volcanic explosions.

After being dormant for 120 years, Mount Agung on the Indonesian island of Bali erupted in 1963. The explosion was the first large volcanic eruption in 51 years.

UPI

The doubts about a relationship between volcanic eruptions and climatic changes have fostered several new studies based on two different approaches. First, theorists are trying to understand how single volcanic explosions cause changes in weather. With this knowledge they may be able to calculate the number of volcanic explosions required to produce a given climatic change. Pollution the earth's upper atmosphere by th exhaust of high-flying supersonic ai craft may act to change climate in th same manner as volcanic explosions Thus a thorough understanding of th effects of volcanic explosions on cl mate is needed to insure that huma kind itself does not inadvertently a fect climate. Second, researchers ar trying to determine if epochs wit cooler climates had significantl more volcanic explosions than thos with warmer climates.

In order to understand how th eruption of a remote volcano produces worldwide weather effects, w must first understand volcanic explosions. Volcanoes are little more tha cracks in the earth's surface throug which molten rock, or magma escapes. The magma is produce mainly at the edges of crustal plate so a global map of the locations o volcanoes shows the crustal plate outlined by volcanic "rings of fire." The magma is formed far below th earth's surface, where pressures ar very high. The high pressure force gases—the most important bein water, carbon dioxide, and sulfurou compounds—to dissolve in the molten rock. As the magma reaches th surface through volcanic vents, th pressure is reduced and the dissolve gases are released.

Many volcanoes have magma tha is very fluid. When they erupt, th gases in their magma escape easily as lava pours out onto the ground Such volcanoes produce about twenty or more minor explosions each year which emit volcanic ash and gas int the earth's lower atmosphere, wher clouds and rain quickly wash the volcanic pollution from the sky. Som volcanoes, particularly those aroun the Pacific Ocean, have very viscou magma in which gas bubbles ar trapped. When that magma reache the earth's surface and pressure is reduced, a major explosion occurs Such an explosion was the eruptio of Krakatoa in the Sunda Strait of th Dutch East Indies in 1883, estimate to have been ten times as powerful a the largest hydrogen bomb explode in the atmosphere by the Unite States. Krakatoa threw clouds of ash at least thirty miles high, into th earth's atmosphere.

The stratosphere is the region o the atmosphere above an average altitude of about nine miles. It is a cold dry place, where rain clouds neve form. When a volcanic explosion in

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jects material into the stratospher the volcanic ash and gas are n washed away but remain for years before finally falling or being carried b wind systems down to the lower a mosphere. Winds in the stratospher transport the ash and gas around th earth and spread them over the entir hemisphere of the eruption and sometimes over both hemispheres of th globe.

Volcanic gases are rich in sulfu dioxide, which is also an importa pollutant produced by the burning o fossil fuels in industrial plants, automobiles, and aircraft. Sulfur dioxid is very reactive chemically. Injecte into the stratosphere by a volcanic explosion, it is converted through photochemical processes into small droplets of sulfuric acid. These droplet and small volcanic ash particles which together make up the fog note by Franklin, affect weather mainly b interfering with the transmission o light.

The earth's meteorology is largel controlled by a balance between th amount of visible sunlight absorbe by the planet and the amount of invisible infrared light radiated back t space by the earth. (Infrared light i radiation of longer wavelength tha the red portion, the long end, of th visible spectrum.) Volcanic particles in the earth's atmosphere reflec visible sunlight back into space before the light can reach the earth' surface and be absorbed. As a result the earth's surface cools off. On th other hand, the particles also absor infrared energy from the earth's surface, making it more difficult for th earth to radiate that energy back t space. This tends to warm the earth' surface. The same process explain why cloudy nights are warmer tha clear ones, for clouds also prevent infrared energy from escaping. Volcanic particles thus produce bot cooling and warming trends, but th cooling trend is more pronounce than the warming trend, so on balanc the earth cools slightly after a larg volcanic explosion.

Striking optical effects are ofte seen following large eruptions, confirming the action of volcanic particles in interfering with incomin sunlight. Even minor volcanic explosions, such as the 1968 eruption o Fernandina Island in the Galápago and the 1974 eruption of Fuego i Guatemala, caused spectacular re sunrises and sunsets in the Norther Hemisphere. The red skies painted b

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the nineteenth-century English romantic landscape artist J.M.W Turner may reflect the many volcanically colored twilights of the perio in which he worked. And the phras "once in a blue moon" may hav originated from observations of blu and green suns and moons after volcanic eruptions. Such blue and gree colors were seen in the tropics fo several weeks following the Krakato eruption in 1883.

An even more beautiful phenomenon, occasionally seen after eruptions, is a large ring around the sun reddish at its outer border and blu white toward the center, name Bishop's ring for the Reveren Sereno E. Bishop of Honolulu, wh first described the occurrence ten day after Krakatoa's explosion. Bishop' ring was seen throughout the Northern Hemisphere for more than tw years following that eruption.

The cause of such phenomena a blue and green moons was a puzzl to which scientists have devote much speculation. To discover the origin of these optical events, high-flying aircraft and balloons have bee used to collect samples of stratospheric air after volcanic eruptions. Tiny sulfuric acid particles and fragments of lava were found in the samples. Their small size and the fac that light behaves like a wave provide the explanation for the optical effects and also for the way in which these particles affect weather.

The red of the normal, cloudless sunset sky results from two processes. First, as the sun sets, its beam passes through larger and large amounts of atmosphere. Air molecules, which are much smaller than the wavelength of visible light, scatter blue light out of the sun's beam more readily than red light because the wavelength of blue light is toward the short end of the visible spectrum. Consequently, the solar beam becomes more and more depleted o blue light. Second, the reddened beam strikes more and more dust particles as the sun sinks over the horizon. Like volcanic particles, ordinary dust particles are approximately the same size as the wavelength of visible light—about two hundred-thousandths of an inch in diameter. The dust particles efficiently scatter all the colors of visible light, so they are able to scatter the reddened solar beam down toward the ground where we see it as the twilight color.

Volcanic eruptions cause an ex-

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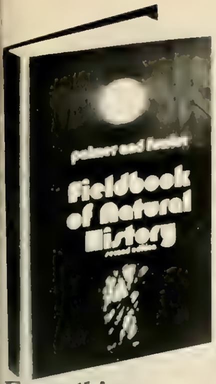
traordinary increase in the number c particles in the stratosphere; after a eruption, there are perhaps two bi lion particles in a column the heigl of the stratosphere and one inc square. These particles are so minuscule, however, that a line of two hundred thousand of them would stretc only one inch. Nevertheless, the produce more spectacular sunset than ordinary dust both because c their vast numbers and because the circulate at extremely high altitudes making the sunset display last longer Volcanic sunsets are rich in brillian hues of violet and pink seldom see in normal sunsets. These colors occu because, in addition to volcanic particles, the stratosphere contain ozone, a gas that absorbs yellow an green light. The moon and the mid day sun may appear blue or gree after a large eruption because the volcanic particles scatter more red ligh than normal out of the sunbeam o moonbeam, leaving the beam wit proportionally more blue and gree light than we are used to.

Thus, there is direct observationa evidence that volcanic dust particle strongly scatter sunlight. Some of thi radiation is scattered away from th earth's surface, causing it to cool The cooling tendency is partly counteracted, as previously mentioned because the particles also prevent infrared energy from escaping from th earth's atmosphere. Volcanic particles are about the same size as th wavelength of visible light—approximately one-twentieth the size of th wavelength of infrared light. The therefore affect visible light mor than infrared light, with the net resul that the earth cools off worldwide following a major volcanic eruption.

Changes in the earth's atmospheri conditions after an eruption are usually given in terms of average temperatures because temperatures are mor easily deduced than other atmospheri variables, such as precipitation, particularly for the era before weathe was first recorded and measured (about 1750). Averages are used because weather is so variable from time to time and place to place tha it is difficult to describe changes Moreover, except for very recen times, information on average temperatures is often all that is available Unfortunately, average temperature changes are usually small and can be misleading. For example, average summer temperature in Brunswick Maine, in 1816—the "year withou



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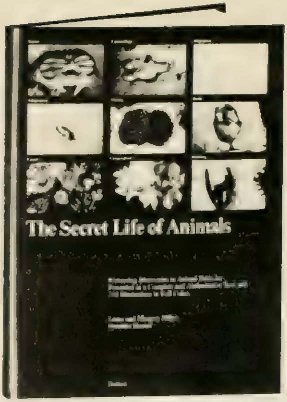

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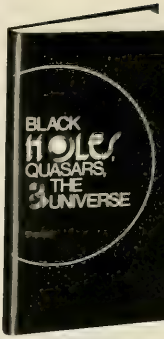

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summer"—was only a few degree Fahrenheit lower than normal. Nonetheless, this small summer coolin was quite significant for it was accompanied by severe storms. Because of the storms, northern Nev England had frost during that entir summer except for two periods o slightly more than three weeks each The cooling after other very large volcanic explosions, averaged over th hemisphere covered by the ash an sulfuric acid particles emanatin from the explosion, has also been estimated to be only one or two degree Fahrenheit.

One interesting sidelight of a comparison between calculated change and observed changes in average temperature caused by volcanic explosions is that a single explosion doe not alter the temperature as much a is theoretically possible. The volcanic particles injected into the stratosphere fall out of the sky after one o two years. The earth, however, resists global temperature changes o this small time scale, primarily because it takes a long time to warm o cool the oceans. This means that i many volcanoes explode in rapid succession, temperatures are likely to drop more than they would following a single eruption. Likewise, a series of many small volcanic explosions can, over a long period of time, produce effects whose magnitude is as great as that following a single really large explosion.

Several researchers, H. H. Lamb among them, have investigated the number of volcanic explosions that have occurred in rapid succession within a period of a few years over the centuries. Lamb found that we live in a period that is markedly deficient in moderate and large volcanic explosions as compared to the period from 1500 to 1912. The only notable eruption since 1912 was the aforementioned one of Mount Agung in 1963. Between 1500 and 1912, by contrast, there was, on the average, one eruption of moderate or great intensity every four years. Evidence of the magnitude of most of those eruptions is indirect. For example, in exploring the period prior to 1880, Lamb had to use reports of vivid sunsets and measurements of ash fall near volcanoes to deduce the magnitude of the explosions. Fortunately, in 1880, measurements began to be made of the amount of sunlight reaching the earth. These measurements clearly show the loss of sunlight fol-

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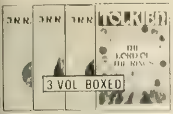

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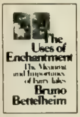

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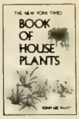

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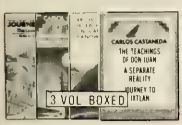

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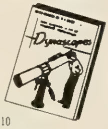

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lowing several volcanic explosions—just the information theorists need in order to calculate the difference in average temperature between the present nonvolcanic period and the period from 1880 to 1912. The difference, due to volcanic explosions, is almost 1°F. Observations of temperatures show that the earth has been warmer since 1912 than it was during the period from 1500 to 1912 by just about the same amount.

Climatologists do not agree on the cause of this observed warming. It may be due to factors other than volcanoes, for instance, fluctuations in solar radiation. But the agreement between the calculated temperature change due to volcanic activity and the observed change suggests that the large number of volcanic explosions between 1500 and 1912 played a major role in altering the terrestrial climate. If volcanoes should again explode as often as they did during the period from 1500 to 1912, mountain glaciers and polar sea ice might begin to expand, bringing hardship and suffering to those in climatologically marginal areas of the world.

Climatologists also disagree on the cause of ice ages. Some scientists theorize that volcanoes could be the cause of ice advances, or glacials, but there is no consensus about the precise correlation between ice ages and volcanic activity. Although volcanoes might cause glacials, the reverse is also possible—glacials might cause volcanic explosions. In an ice age, great masses of water are shifted from the oceans to the ice caps. That shift subjects the earth's crust to considerable stress and could lead to enhanced volcanic activity through motion of the crustal plates. Although we do not know whether volcanoes caused the glacials or vice versa, new evidence about the histories of glacials and volcanic explosions has established some connection between the two phenomena.

During the last two million years, the approximate span of the human presence on this planet, there have been many glacials, each of which lasted about 100,000 years. Prior to two million years ago, there was a period of more than one hundred million years during which there were no glacials and the earth was so warm that the Antarctic polar cap did not exist.

The history of volcanic explosions during ice ages is found on the ocean floor, which preserves a record of all the debris that has fallen into th ocean over the millennia, with th youngest material in the top layer. worldwide study of volcanic as layers in ocean sediments has foun that there were many more violen volcanic eruptions during the tw million years of the ice ages than dur ing the preceding tens of millions o years.

Further evidence comes from th ice sheets in Greenland and Antarctica, which contain ice at their bottom layers that originally fell as snow 100,000 years ago at the beginning o the last ice advance. Cores from thos ice sheets also contain layers of volcanic dust. The cores show that between 30,000 and 16,000 years ago from the peak of the last glacial to it end, a tremendous number of volcanic exposions took place, perhap as many as one eruption every tw years. Theoretical calculations suggest that these volcanic explosion caused substantial cooling, which contributed to the low temperatures a the height of the last glacial.

Although volcanic activity was common at the peak of the last glacial, there is no evidence of an extended period of volcanic activity a the initiation of the last ice advance about 100,000 years ago. But the available data do not rule out the possibility of a great number of eruptions over a fairly short period of time a the beginning of the glacial. Some climatologists believe that such an intense period of volcanic activity could trigger an ice advance. In fact, a dramatic worldwide cooling, during which the earth plunged for a thousand years from interglacial to full glacial conditions, took place in a single century about 90,000 years ago. This type of sudden cooling, which would be disastrous for modern society, could play a role in starting glacials and could be caused by a short period of intense volcanic activity.

Lamb's work tends to show that abnormal weather follows single large volcanic explosions. Of course, volcanic explosions do not cause all the unusual weather on the earth nor do they account for all the climatic changes. Nevertheless, volcanic explosions probably have caused some of our most remarkable weather. They may have been involved in some of our most important climatic changes. And volcanoes will probably continue to influence climate and weather in the future. □

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A Naturalist at Large

by Bernard Nietschman

The Nicaraguan Skin Connection

Crocodiles are being decimated because of the Big Buyer. When he doesn't come, the local dealer also takes a beating

When I was in graduate school reading papers on ecological research done in the tropics, I often wondered why anyone ventured to foreign places if all investigations were as dry in the process as they often were in the product. The accounts of many studies were written as if the field work took place in a cultural and personal vacuum; as if the researcher had suddenly been teletransported to the site and, by means of clairvoyance or immaculate conceptual perception, had faultlessly initiated and completed the research project in one blinding flash of academic ingenuity.

Let me tell you that field research does not work this way. Even though exorcised from scientific articles and books, there are awkward, stumbling, sometimes agonizing, and often humorous personal encounters and problems that give each research experience a special character and texture. These unusual personal encounters are a significant part of what keeps us going back into the field.

When I returned to the east coast of Nicaragua in 1971 to continue a research project first begun in 1968, one of the first people I saw at the small airport outside of Bluefields was Mr. Seymore (Robinson is his last name, but in this part of the world the surname is usually dropped for informality and the Mr. retained for politeness). He was still the eternal optimist, scanning the passengers for some important but long overdue Godot who was to be the key figure in one of his "strike it rich" business scenarios. Seeing him again recalled one of my more unusual and tragic field experiences.

After we exchanged personal and family news, I could not help but ask him about the house at Cotton Tree. He assured me that it was still there, pretty as ever but wanting a coat of paint. As we talked, I thought of my first trip to the area, of Mr. Seymore, and of the house at Cotton Tree.

In 1968 I went to Nicaragua to study the impact of commercial hunting and fishing on the local fauna and on the subsistence system of the Miskito Indians. With little idea of what I might encounter at the designated research site, I left my wife and son in Managua, the capital, and went on to Bluefields to reconnoiter the situation and rent a house that would be our main study base.

There are two ways to travel to Bluefields from Managua. You can go by air on a one-hour flight or you can spend all day going overland and by river. I chose the latter in the hope of seeing as much of the country as possible. It was September and the rains had started. The 180-mile trip by microbus over the Rama Road was punctuated by constant bouncing and sloshing through ruts, mud, and water. During the entire journey, the number two driver hung out the window yelling "Rama, Rama, Rama" in a melodic staccato, hoping to pick up more travelers. By noon we had reached the end of the road and the town of Rama, which was something of a letdown after seven hours of "Rama, Rama, Rama."

The Río Escondido was just below flood stage and its muddy, debris-strewn waters lapped at the improvised cobweb wharves. Tied to one of the wharves was a strange, almost amphibianlike craft, which was to be our means of transport for the remaining eighty miles to the coast. The *Bluefields Express* was a patchwork vessel pieced together from a surplus PT boat with a bus body welded to its deck.

Like a platypus, the town of Bluefields is a bizarre sum of disparate elements that defy characterization. The cascade of my first night's impressions led to a cross-cultural overdose: loggers, ranchers, pioneer farmers, missionaries, and shrimp boat crews crowded the main streets. Blasts of Jim Reeves country and western music spilled from the open doorways of cantinas named Miami Beach, Tamarindo Number 2, OK Corral, Torpedo Alley, and the Bay of Pigs, drowning out multilingua Spanish, Creole English, and occasional Chinese and Miskito stree conversations. Trucks and car avoided potholes and people as the navigated the few short roads that terminated either at the edge of the lagoon or the surrounding rain forest Cerveza Victoria and Ron Tropica signs hung from second-floor balconies of British-colonial woode buildings that sagged from damp rot

I was directed to Sunshine Down's "Magestic Saloon" for goo food, said to be the best in Bluefields It was true. Big, fresh sea shrimp cooked Creole style with plenty o onions, vinegar, lime, garlic, black pepper, and a local *salsa picante*. Honest bread with a hard crust and a solid feel to it and all the Chontales ranch butter you wanted. And a huge pitcher of soursop *fresco*—perhaps the best drink in the tropics.

While eating, I watched the sidewalk parade through the open space beneath the saloon doors: bare feet of all sizes and shapes; rubber Tico boots, some split and wire-stitched; men's pointed, high-heeled, black leather *gallo* shoes; rubber thongs; and one pair of Sears canvas wedgies, the kind with the little flowers and the toe hole cut out of the front.

After visiting the Supermercado William Woo (one shopping cart from who knows where) to buy some nails to hang my mosquito net, I took a room at the Hollywood Hotel and fell asleep wondering how—in that cultural maze—I was going to find a house to rent.

The next day it was hard to distinguish the knocking at my door from the drum roll of early morning rain beating on the corrugated tin roof. Standing on the veranda outside my room was an older man, dressed in a wool suit, a hat, and amazingly, a starched white shirt.

"Not to molest you this fine mornin', but I come to engage you in our dealin' with the skins," he said in delightful Creole English.

I was sure he had the wrong morning and fairly certain he had the wrong man as well. He mistook my

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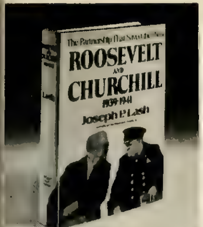

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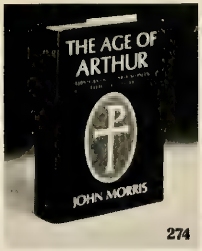

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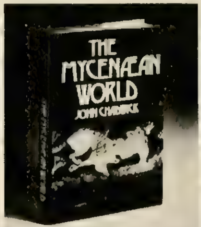

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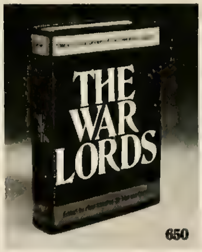

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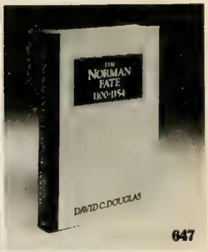

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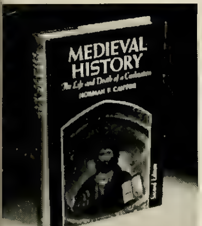

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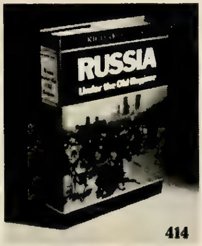

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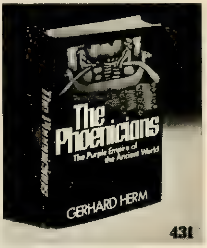

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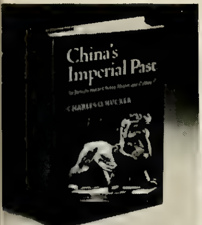

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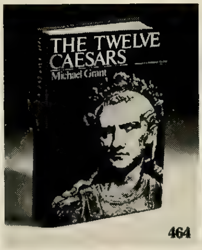

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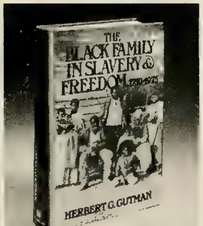

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hesitation as a sign of acceptance and went on.

"My name is Seymore Robinson, pleased to meet your acquaintance, and I made to understand that you is here to see me."

I explained that I was not there on business and was not looking for him, although I was happy to meet him.

Looking somewhat dejected, he said, "These last days things a little hardish so I is keeping bright eyes for my business contact."

After telling me that he owned a small store and also bought and sold many things on the side, he inquired what had brought me to Bluefields. I told him that I was looking for a house to rent and started to explain about my research project.

Interrupting, Mr. Seymore said, "Then this is your lucky day. You is here on business and you come to the right man. I have me own personal house yonder in Cotton Tree which is available at the moment. This be the proper place for you, and God willin', we'll take a stroll and see it."

While we waited for the rain to let up, Mr. Seymore explained that Cotton Tree was an adjacent neighborhood named for a prominent, large tree on the bluff over the lagoon. He extolled the virtues of his house. "It catch a fine sea breeze that keep the fly from humbugging you."

When the rain stopped, we walked to Cotton Tree, passing several desirable looking houses, all built on stilts, with wooden sides and metal or thatch roofs. But no, Mr. Seymore informed me that these were only ordinary houses and to pay no mind to them. I had to agree with him when he stopped in front of a bright, Shell Station yellow house with a shiny new tin roof. To reach the front porch, eight feet above the ground, Mr. Seymore pointed to a tree house ladder and up we went.

"I'm gon'a fix this to your satisfaction, Mr. Bernard. This be a first-class place for you."

He unlocked the door and pushed it open. "I surely hope we does reach an agreement, God willin'," he added, as he opened the wooden shutters.

It took a moment for my eyes to adjust to the suddenly brightened interior. At first, all I could see was a floor completely covered by dark bumps. I squinted to get a better view. There could be no doubt about it. In the house that we might live in—the place that would serve as a field base while we studied the impact of commercial exploitation on local fauna—were crocodile skins, from wall to wall, neatly rolled like so many loaves of bread, row upon row.

Stunned, I could only muster a weak, stuttering question. "How many hides do you have here, Mr. Seymore?"—as if the exact number would somehow defuse my shock.

Mr. Seymore smiled as he rocked up on his toes, the extra height giving added emphasis to his words. "Mr. Bernard, I got me one thousand nine hundred in this here room and another four or five hundred in the next room. Mostly they is crocodilly but some be alligator that favor the crocodilly. Right now the place have a high scent but don't let these animals worry you none, Mr. Bernard. I'm gon'a fumigate this place and paint it up, pretty, pretty."

Hardly paying any attention to what Mr. Seymore was saying, I stared at the brownish black and light yellow mass of bundles. Twenty-four hundred skins. Think of it. Two thousand four hundred crocodiles and caimans. This place was the Forest Lawn of the reptile world.

Mr. Seymore led me through the skins, pointing to bare spots on the floor where we could place our feet.

"Are these skins fresh?" I asked.

"Why no, man. These skins be prepared. They been salted three, four times. They be all right. I'll fix the place up to your likin'," he remarked with a sweeping gesture, encouraging me to imagine the Bluefields House Beautiful, as if a coat of paint could cover a cemetery.

"Don't do *anything* until my wife sees the house. I wouldn't want you to go to any extra trouble."

Now more interested in the skins than the house, I asked how he obtained them.

"They come from my little sellin' and buyin' business that I have on the side. I does buy all kinda skins and things: water dog, tiger, tigercat, peludo, 'awksbill, calipee, and such like thing."

Mr. Seymore then went on to explain that he had been buying skins for many years, purchasing them from hunters, loggers, ranchers, and farmers from as far away as the Costa Rican border. These people have to come to Bluefields for supplies, and when they do, they bring the skins to Mr. Seymore or to one of the other buyers.

"But all is gettin' scarce now. Most of these skins here are smallis Only one, one, be big. So I got to w to get the right price. That is the spe ulatin' part of the skin dealin'. I waiting on a man who is to come Bluefields, check out these skins, a buy them."

We then launched into a lengt discussion on the decline of vario species, the increase in the mark prices, where the skins were sent, a the survival chances for these anima and for Mr. Seymore's business.

"If I don't buy, then the peop gon'a sell to the next man. The ma ket gettin' a little tightish count of t laws in the States. But I sellin' no to Europe and Japan. They is the on buyin'."

I thanked Mr. Seymore for his he and the information, said goodby and retraced my steps through the ca pet of skins. Even though the rain h stopped, and the sun was now war and powerful, it was to be a cold a gray day for me.

During the months that followe Mr. Seymore and I became friend Strange. While he was trying to e port skins, hides, hawksbill shell, a other items, I was writing reports the Nicaraguan government pressin for new and stronger conservatio laws. The differences in our view points were enormous, but we r mained friends and he taught me great deal about his business an about the varieties of wildlife in th area. He would show me his records detailing the types and numbers o wild animal products that he had pu chased and exported to distant ma kets. He knew how I would use thi information, yet he offered it to me "You got to know these things, Mr Bernard, for your work."

No, my family and I never rente that pretty yellow house that was graveyard on the inside. But afte studying faunal decline for severa years, we felt that we had lived there nonetheless.

Sometime after my reunion wit Mr. Seymore, I asked him if he ha ever sold the skins.

"I never get the chance to sel them," he replied. "Worm and bu bore hole in them and I had to das the whole shipment away in the la goon. The big buyer never come."

Bernard Nietschmann, taking break from his research on dugongs is traveling around Australia b train, looking for future column ma terial.

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The Problem of Perfection

The exquisite design of some creatures poses a challenge to Darwin's theory of natural selection

In 1802, Archdeacon Paley set out to glorify God by illustrating the exquisite adaptation of organisms to their appointed roles. The mechanical perfection of the vertebrate eye inspired a rapturous discourse on divine benevolence; the uncanny similarity of certain insects to pieces of dung also excited his admiration, for God must protect all his creatures, great and small. Evolutionary theory eventually unraveled the archdeacon's grand design, but threads of his natural theology survive.

Modern evolutionists cite the same plays and players; only the rules have changed. Now we are told, with equal wonder, that natural selection is the agent of exquisite design. As an intellectual descendant of Darwin, I do not doubt this attribution. But my confidence in the power of natural selection has other roots: it does not arise from the existence of ''organs of extreme perfection and complication,'' as Darwin called them. In fact, Darwin saw truly exquisite design as a problem for his theory. He wrote:

> To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I confess, absurd in the highest degree.

In last month's column, I invoked gall midges to illustrate the opposite problem in adaptation—structures and behaviors that seem senseless. But ''organs of extreme perfection'' have an only too evident use; the difficulty lies in explaining how they developed. In Darwinian theory, a complex adaptation does not arise in a single step, for this would confine natural selection to the purely destructive task of eliminating the unfit whenever a better-adapted creature suddenly appeared. Natural selection has a constructive role in Darwin's system: It builds adaptation gradually, through a sequence of intermediate stages, and brings together, in sequential fashion, elements that often seem to have meaning only as parts of a final product. But how can a series of reasonable intermediate forms be constructed? Of what value could the first tiny step toward an eye be to its possessor? The dung-mimicking insect is well protected, but can there be any edge in looking only 5 percent like a turd? Darwin's critics referred to this dilemma as the problem of assigning adaptive value to the ''incipient stages of useful structures.'' And Darwin rebutted by trying to find the intermediate stages and by specifying their utility.

> Reason tells me, that if numerous gradations from a simple and imperfect eye to one complex and perfect can be shown to exist, each grade being useful to its possessor . . . then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, should not be considered as subversive of the theory.

The argument still rages, and organs of extreme perfection rank high in the arsenal of modern creationists.

Every naturalist has his favorite example of an awe-inspiring adaptation. Mine is the ''fish'' found in several species of the freshwater mussel *Lampsilis*. Like most clams, *Lampsilis* lives partly buried in bottom sediments, with its posterior end protruding. Riding atop the protruding posterior is a structure that looks for all the world like a little fish. It has a streamlined body, well-designed side flaps complete with a tail and even an eyespot. And, believe it or not, the flaps undulate with a rhythmic motion that imitates swimming.

Most clams release their eggs directly into the surrounding water, where they are fertilized and undergo their embryonic development. But female unionids (the technical name for freshwater mussels) retain their eggs within their bodies, where they are fertilized by sperm released into the water by nearby males. The fertilized eggs develop in tubes within the gills, forming a brood pouch, or marsupium.

In *Lampsilis*, the inflated marsupium of gravid females forms the ''body'' of its ersatz fish. Surrounding the fish, symmetrically on both sides, are extensions of the mantle, the ''skin'' that encloses the soft parts of all clams and usually ends at the shell margin. These extensions are elaborately shaped and colored to resemble a fish, with a definite, often flaring ''tail'' at one end and an ''eyespot'' at the other. A special ganglion located inside the mantle edge innervates these flaps. As the flaps move rhythmically, a pulse, beginning at the tail, moves slowly forward to propel a bulge in the flaps along the entire body. This intricate apparatus, formed by the marsupium and mantle flaps, not only looks like a fish but also moves like one.

Why would a clam mount a fish on its rear end? The unusual reproductive biology of *Lampsilis* supplies an answer. The larvae of unionids cannot develop without a free ride upon fishes during their early growth. The larvae of most unionids possess two little hooks. When released from their ther's marsupium, they fall to the ttom of the stream and await a pass-g fish. But the larvae of *Lampsilis* k these hooks. In order to survive, y must enter a fish's mouth and ve to favored sites on the gills. The atz fish of *Lampsilis* is an animated coy, simulating both the form and vement of the animal it must at-ct. When a fish approaches, *Lamp-is* discharges larvae from the arsupium; some of them will be allowed by the fish and find their y to its gills.

The strategem of *Cyprogenia,* a re-ed genus, emphasizes the impor-ce of attracting a host. These mussels "go fishing" in a manner subsequently reinvented by disciples of Izaak Walton. The larvae attach themselves to a bright red "worm" formed by a protein manufactured within the mother's body and are extruded through the exhalant siphon. Several observers report that fish seek out and eat these "worms," often pulling them, when only partly extruded, from the female's siphon.

How could the decoy fish ever have evolved? How did the marsupium and mantle flap come together to effect their ruse? Lucky accident or preordained direction may appeal to our intuition more than gradual construction by natural selection through some intermediate forms that, at least in their initial stages, could not have looked much like a fish. The intricate fish of *Lampsilis* is a classic illustration of a deep dilemma in Darwinism. Can we possibly devise an adaptive significance for the incipient stages of this structure?

The general principle advanced by modern evolutionists to solve this dilemma calls upon a concept with the unfortunate name of "preadaptation." (I say "unfortunate" because the term implies that species adapt in advance to impending events in their evolutionary history, when exactly

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the opposite meaning is intended.) The success of a scientific hypothesis often involves an element of surprise. Solutions often arise from a subtle reformulation of the question, not from a brute force collection of new information in an old framework. With preadaptation, we cut through the dilemma of a function for incipient stages by accepting the standard objection and admitting that intermediate forms did not work in the same way as their perfected descendants. We avoid the excellent question, What good is 5 percent of an eye? by arguing that the possessor of such an incipient structure did not use it for sight.

To invoke a standard example, the first fishes did not have jaws. How could such an intricate device, consisting of several interlocking bones, ever evolve from scratch? "From scratch" turns out to be a red herring. The bones were present in ancestral forms, but they were doing something else—they were supporting a gill arch located just behind the mouth. They were well designed for their respiratory role; they had been selected for this alone and "knew" nothing of any future function. In hindsight, the bones were admirably preadapted to become jaws. The intricate device was already assembled, but it was being used for breathing, not eating.

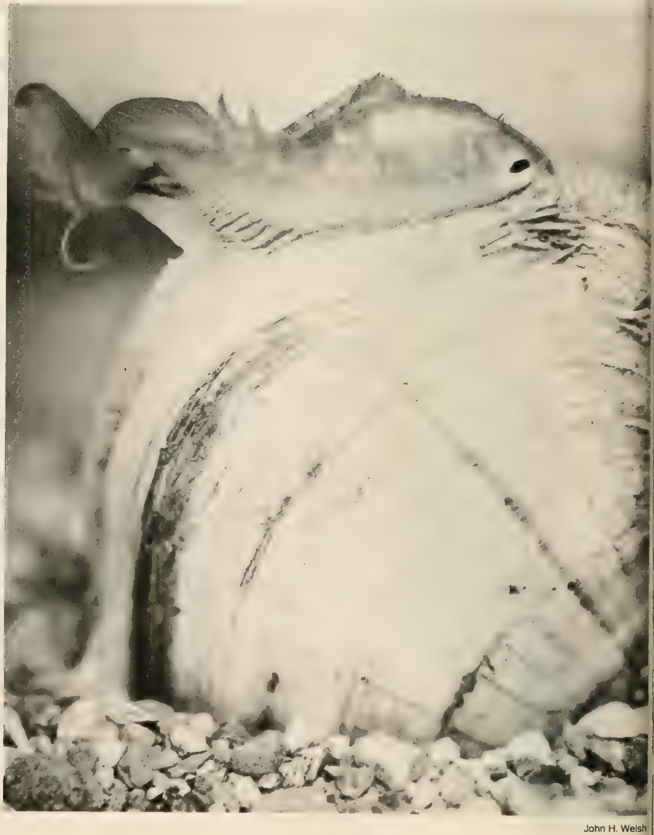
Similarly, how could a fish's fin ever become a terrestrial limb? Most fishes build their fins from slender parallel rays that could not support an animal's weight on land. But one peculiar group of freshwater, bottom-dwelling fishes—our ancestors—evolved a fin that had a strong central axis and only a few radiating projections. It was admirably preadapted to become a terrestrial leg, but it had evolved purely for its own purposes in water—presumably for scuttling along the bottom by sharp rotation of the central axis against the substrate.

In short, the principle of preadaptation simply asserts that a structure can radically change its function without altering its form as much. We can bridge the limbo of intermediate stages by arguing for a retention of old functions while new ones are developing.

Will preadaptation help us to understand how *Lampsilis* got its fish? It might if we can meet two conditions: (1) We must find an intermediate form using at least some elements of the fish for different purposes; (2) We must specify functions other than visual decoy that the protofish could fulfill while it gradually acquired its uncanny resemblance.

Ligumia nasuta, a "cousin" of *Lampsilis*, seems to satisfy the first condition. Gravid females of this species do not have mantle flaps, but they do possess darkly pigmented, ribbon-like membranes that bridge the gap between partly opened shells. *Ligumia* uses these membranes to produce an unusual, rhythmic motion. The opposing edges of the ribbons part to form a gap several millimeters i length at the mid-part of the shell Through this gap, the white color o the interior soft parts stands ou against the dark pigment of the ribbon. This white spot appears to mov toward the back of the shell, as wave of separation propagates itsel along the membranes. These wave may repeat about once every two seconds. J.H. Welsh wrote in the May 1969 issue of *Natural History:*

> The regularity of the rhythm is remarkably constant. To a huma observer, and perhaps to a fish, th eye-catching feature here is th white spot that appears to mov against the dark background of th mussel and the substrate in whic it is half buried. Certainly thi could be a lure to host fish and ma represent a specialized adaptatio from which the more elaborate fishlike lure evolved.



John H. Welsh

"Fish" with eyespot and tail rides atop Lampsilis ventricosa. *When a fish nears, the clam discharges larvae; some will be ingested by the fish and find their way to its gills, where they will mature.*

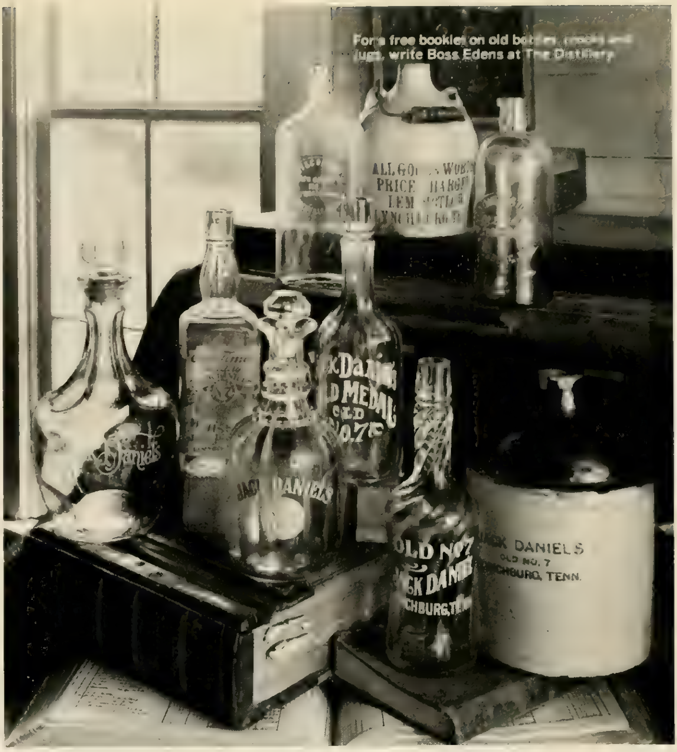
We are still dealing with a device
attract fish, but the mechanism is
stract, regular motion, not visual
micry. If this device operated
ile the flaps were evolving and
wly building their resemblance to
ish, then we have no problem of
ipient stages. Motion of the mantle
racted fish from the start; the slow
velopment of a protruding fish only
hanced the process.

Lampsilis itself fulfills the second
ndition. Although no one has de-
d the significance of visual resem-
nce as a lure, our leading student
Lampsilis, L.R. Kraemer, ques-
ns the common assumption that
apping'' of the body serves only to
nulate the movements of a fish. She
lieves that flapping may have
olved either to aerate the larvae
thin the marsupium or to keep them
spended in the water after their re-
se. Again, if flapping provided
se other advantages from the start,
n the fortuitous resemblance of
ps to fish might be a preadaptation.
e initial, imperfect mimicry could
improved by natural selection
ile the flaps performed other im-
rtant functions.

Common sense is a very poor guide
scientific insight for it represents
ltural prejudice more often than it
lects the native honesty of a small
y before the naked emperor. Com-
on sense dictated to Darwin's crit-
that a gradual change in form must
licate a progressive building of
nction. Since they could assign no
aptive value to early and imperfect
ges of a function, they assumed ei-
r that early stages had never ex-
ed (and that perfect forms had been
ated all at once) or that they had
t arisen by natural selection. The
nciple of preadaptation—func-
nal change in structural continu-
—can resolve this dilemma. Dar-
n ended his paragraph on the eye
th this perceptive evaluation of
ommon sense'':

> When it was first said that the sun stood still and the world turned round, the common sense of mankind declared the doctrine false; but the old saying of *Vox populi, vox Dei* [the voice of the people is the voice of God], as every philosopher knows, cannot be trusted in science.

*phen Jay Gould teaches biology,
ology, and the history of science at
rvard University.*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Alton Ochsner, M.D.

ON THE ROLE OF VITAMINS C AND E IN MEDICINE

A world-famous surgeon tells you how and why he uses these two essential vitamins

PUBLISHER'S NOTE: *Dr. Ochsner is one of the outstanding international leaders in modern medical progress. Now Emeritus Professor of Surgery at Tulane University School of Medicine, he maintains an active practice at the famed Ochsner Clinic in New Orleans. As a member of our Editorial Board, we have asked him, out of his unique long personal experience with vitamins C and E, to tell you how and why he uses them.*

—Richard Stanton

The American public has become very health-conscious which is extremely desirable because most of us, when we arrive in this troubled world, are endowed with the most marvelously efficient mechanism ever devised, and much depends on us whether this mechanism will function properly and last without becoming prematurely obsolete.

No longer is longevity the principal consideration, and rightly so, because the desideratum is healthy and useful life as long as possible. Because of the health-consciousness of the public, people are avid for information concerning their health and factors which may improve it. It is inconsistent, however, that individuals concerned about remaining healthy and prolonging a useful life, adopt practices which are definitely known to accelerate aging, produce disabling illness, and shorten life. These are the use of tobacco, the abuse of alcohol, and excesses of all kinds.

Vitamin use has been a controversial subject for a number of years, and although vitamin deficiency is extremely undesirable, can be hazardous and even fatal, often vitamins are used when they are not needed. However, with advancing age it is probably desirable to use vitamin supplements because of de-

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The Many Ways to Beget a Frog

by Martha L. Crump

A diversity of reproductive strategies enables a vast array of species to coexist in the same area

Frogs in temperate climates lay their eggs in water; the tadpoles hatch and eventually metamorphose into small replicas of the amphibious adults while still in their aquatic birthplace. This strategy represents a mode of reproduction that has proved successful for many frog species. Things don't work quite that way in the tropics, however, where frog reproduction is a more complicated and diverse affair.

Clutches of pearl white frog eggs cached under rocks, a brown and iridescent red frog carrying six black tadpoles on its back, dark green frogs depositing eggs on leaves more than three feet above the surface of a pond, a large mass of white foam with wriggling tadpoles inside: these are but a few examples of the many different and highly adaptive reproductive strategies of tropical frogs. Such intriguing adaptations sparked my curiosity and led to a thirteen-month study of reproductive diversity in frogs at Santa Cecilia, Ecuador.

The greatest richness of frog species of any area in the world studied to date is found at Santa Cecilia—a small Quechua village on the north bank of the Río Aguarico, a tributary of the Río Napo, in the upper Amazon Basin—where eighty-one species of frogs live in an area of about two square miles. There are few places in the United States where one can find as many as twenty species of frogs in a similar-sized area.

Eight families of frogs, encompassing twenty-five genera, are represented at Santa Cecilia. Ten of the genera are endemic to South America; the remaining fifteen are also found in Central America. Several of the species are only found in the upper Amazon region, whereas some are widespread throughout the Amazon Basin. The distribution of others is peripheral to the Amazon Basin or restricted to the eastern slopes of the Andes.

One of the first questions that comes to mind about the frogs at Santa Cecilia is, Why are there so many species in this one area? The answer is found in a combination of the geographic location and historical zoogeography. The site is peripheral to both the Amazon Basin and the eastern slopes of the Andes. The result is a composite of species from these two faunal regions. The fact that about 15 percent of the eighty-one species are seemingly rare may indicate that these species are living at or near their ecological limit.

Another possible explanation for the species richness is that the area was probably a forest refugium during the Pleistocene. In 1969, geologist Jürgen Haffer proposed that climatic oscillations during the Pleistocene resulted in alternating series of contractions and expansions of the rain forest in lowland tropical South America. He postulated that during dry phases the forest covered only small, disjunct areas, which would have acted as refugia for forest animals. Local selection pressures would have resulted in intense differentiation among the populations inhabiting the enclaves. During wetter phases, the forests expanded. Where previously isolated populations came together, they formed the present, complex patterns of speciation typical of secondary contact zones. One of the nine refugia postulated by Haffer is the Napo region, in which Santa Cecilia is located.

Of great ecological interest is another question, How are all these species able to coexist? After studying the frog fauna at Santa Cecilia, I have concluded that a major factor enabling coexistence is the high reproductive diversity of the different species. This diversity allows coexistence because of a multidimensional (time and space) partitioning of breeding sites and probably coevolved with extensive speciation during the Pleistocene as a means of coping with the changing environment.

A commonly proposed evolutionary trend regarding reproduction in frogs is that these amphibians have evolved toward greater terrestriality. This trend can be seen in the reproductive strategies of many of the Santa Cecilia frogs. Many of these frogs utilize specialized oviposition sites on land; some have also eliminated the tadpole stage. These specializations allow for partial or complete independence from an aquatic environment for breeding purposes—as opposed to nearly all North American frogs, which deposit their eggs directly in water and whose larvae develop in an aquatic environment.

The reproductive diversity of the Santa Cecilia frog fauna consists of ten "modes of reproduction." This term refers to a combination of egg deposition site and type of development—larval or direct. The modes may be divided into three major categories: (1) Eggs and larvae in water (modes 1–3, 36 species); (2) Eggs out of water, larvae develop in water

A Central American species, Agalychnis callidryas *lays its eggs on leaves that hang over water. After hatching, the tadpoles drop into the water to complete their development.*

Alan Blank; Bruce Coleman, Inc.

(modes 4–6, 25 species); (3) Terrestrial eggs, eggs attached to dorsum of female, direct development (no free-swimming larval stage), or larvae develop within nest on land (modes 7–10, 17 species). The mode of reproduction is unknown for three of the species.

Thirty-four species (46 percent of the frog species at Santa Cecilia) deposit their eggs directly into standing bodies of water, such as ponds, water-filled ditches, lakes, and swamps (mode 1). This group includes mainly toads, one "true frog" *Rana*, tree frogs, and narrow-mouthed toads. Their tadpoles develop in water, eventually metamorphose, and leave the water for land.

These species deposit many small eggs; clutch sizes range from about 140 to more than 8,500 eggs. Mortality is high for both eggs and tadpoles as evaporation often causes the water body used to dry up. In addition, the unguarded eggs and larvae typical of some species are subject to predation by aquatic insects, fish, snakes, and birds. For these reasons, larvae of some species of mode 1 frogs have accelerated development; their strategy is to metamorphose and leave the water as soon as possible.

All of these species have pigmented eggs. The melanin in the eggs may promote adsorption of radiant heat energy, thereby allowing the eggs to develop faster; it may also shield the eggs from harmful ultraviolet radiation. Generally, those species that deposit their eggs in areas most exposed to direct sunlight have the most pigment; those species that deposit their eggs in areas sheltered from direct sunlight have the least.

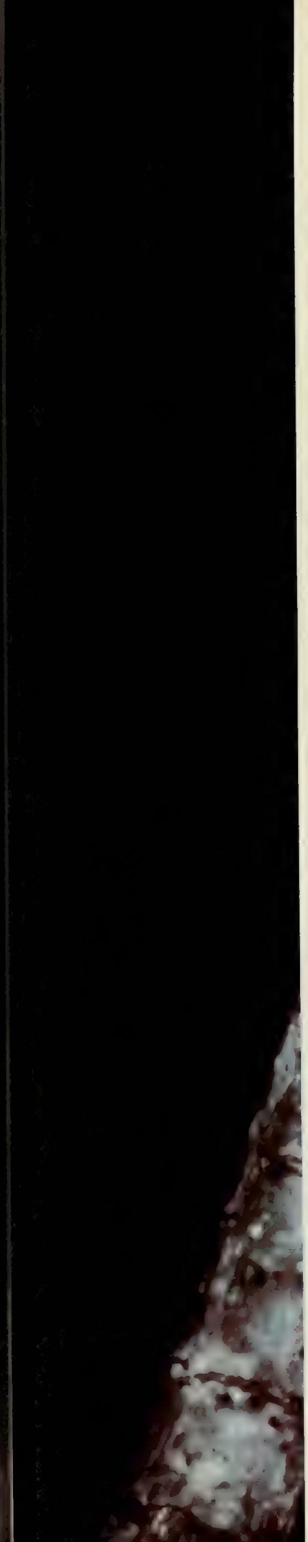
Mode 2 is represented at Santa Cecilia by only one species of tree frog, *Nyctimantis rugiceps*. This species deposits a moderate number of small eggs in a water-filled cavity in a tree or stalk of bamboo. Because the eggs and larvae develop in an isolated site, they are less prone to predation and environmental hazards. However, the tadpoles do have to cope with several problems. Because the cavity is small, they may be subject to mortality due to insufficient oxygen and a limited food supply.

Mode 3 is also represented by only one species of tree frog, the large *Hyla boans*. Males construct basin-like nests in sand, gravel, or mud along the edge of a river. Each male then positions himself beside his nest and calls to attract a female. Males have a protruding prepollex (vestigial digit on the inner side of the first digit on the forefoot) with a long, curved spine. The spine probably aids in grasping the female during amplexus (mating). The female deposits several thousand small, heavily pigmented eggs in the water-filled nest basin. The eggs spread out over the surface of the water, forming a film. The selective advantage of a surface film is that it maximizes an egg's respiratory area in an oxygen-poor environment.

Although the nest allows for minimal predation by aquatic organisms, the tadpoles in the constrained nest provide an easy target for birds. Another disadvantage is that the nests are subject to flooding or drying if the level of the river changes significantly. Food for the tadpoles is also a limited resource in the nest. And yet, in spite of these hardships, the species is highly successful, as demonstrated by its distribution and abundance in the Amazon Basin. The specialization of the isolated egg deposition site must therefore be advantageous.

Fourteen species of frogs deposit their eggs on leaves above water (mode 4). When the tadpoles hatch, they fall into the water below and complete an aquatic larval development until metamorphosis into young frogs. The clutch size of these species ranges from 18 to more than 1,000 eggs. Because most of the species deposit their eggs hidden among vegetation, and so are not exposed to direct sunlight, mode 4 frogs usually have totally unpigmented or only slightly pigmented eggs.

An advantage of this mode of reproduction is elimination of the problems of early development in an aquatic environment (evaporation of



Nuptial excrescences on the thumbs of the male Phyllomedusa dacnicolor *enable him to cling to the back of his mate, piggyback fashion, while she searches for a suitable site to lay eggs.*

James Hanken

Martha L. Crump

By laying its clutch on a leaf, a Hyla *frog has eliminated aquatic predation of its eggs.*

the water and aquatic predators). However, the eggs are subjected to terrestrial predation by insects and snakes. Once the tadpoles enter the water, they face the same environmental pressures as mode 1 species.

One group of mode 4 frogs is the tree frog genus *Phyllomedusa.* The female searches for a suitable oviposition site in the vegetation above water, with the male clinging to her, piggyback fashion. Male *Phyllomedusa* have horny nuptial excrescences on their thumbs, which aid in holding on to the female during the search for a place to lay the eggs.

Some species deposit their eggs on the upper surfaces of leaves; others on the distal tip of a leaf nearest the water. *Phyllomedusa tarsius,* on the other hand, encloses the egg mass with leaves to form a closed nest. This reduces the exposed surface of the clutch and presumably lowers the rate of desiccation, as well as loss due to predation.

The clutch consists of both egg-containing and empty, gelatinous capsules. Eggs are dispersed throughout, but the top and bottom of the egg mass consist mainly of eggless capsules. These "plugs" at the top and bottom provide protection from the sun and dry air. The one at the bottom also serves to keep the nest intact until hatching occurs. The empty capsules also provide an extra source of fluid for the developing embryos.

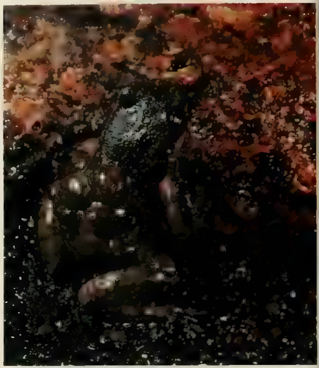
The eggs of six species of the family Leptodactylidae are suspended in a frothy mass of mucus, semen, air, and water, produced by kicking of the male during amplexus (mode 5). This frothy mass, with a consistency of whipped egg whites, is called a "foam nest." Some species produce this foam nest on the surface of a pond; others place the nest in a cavity by the water's edge. Such a nest provides a moist environment for developing eggs and young larvae. Young tadpoles leave the nest and complete their development in the water. The larvae of most of these species have thin, muscular bodies adapted for migrating from the foam nest to adjacent bodies of water.

The tadpoles probably avoid much competition for food and space in the pond by undergoing early development within the security of the foam nest. The nest also provides a protective covering for the eggs and young larvae, eliminating the problems of desiccation and predation. (Who would want to bite through a frothy mass of foam just to eat tadpoles for dinner?)

Martha L. Crump

Phyllomedusa tarsius *encloses its egg mass within leaves. This reduces the problem of desiccation.*

Males of two of the species have prepollical spines for maintaining a secure grip on the female—mated pairs of these species are quite active when kicking up the foam nest. One species has a cluster of horny spines on the chest and greatly enlarged forearm muscles for the same purpose. Clutch sizes for the six species are moderate (235 to 1,740 eggs) and most species have nonpigmented eggs.



OSF Bruce Coleman, Inc

Phyllobates trinitatis *tadpoles hatch on land and are carried to water by the male parent.*

Five species of frogs (family Dendrobatidae) deposit large, moderately pigmented eggs in moist, secluded places on the ground in forest or forest-edge habitats. When the larvae hatch, they are carried to water on the back of one of the adults (whether the male or female transports the tadpoles may be species-specific). Three species of these mode 6 frogs carry their larvae to slow-moving streams, where the tadpoles develop in quiet pools. At this point, the larvae are subjected to aquatic predators and no longer have the protection of the adult.

Two species transport their tadpoles to some constrained body of water such as a cavity in a tree or log. These larvae are less exposed to aquatic predators, but food is probably a limited resource due to the small, confined area.

Adults have no apparent modifications for attachment of the larvae.

The larval body form is slightly depressed and the anteroventral half of the tadpole is slightly concave. This shape probably helps the tadpole fit the slightly curved surface of the adult's dorsum. The tadpoles are capable of maintaining their position on the adult in spite of considerable physical disturbance. Release apparently is a combination of larval and adult activity and probably is correlated with larval age. All of these are small frogs (less than 30 mm) and have low fecundity (9 to 23 eggs).

One species of the family Leptodactylidae produces foam nests in depressions under logs or rocks on land mode 7). The foam nest is similar to hat of mode 5, except that in this case here is total independence of standng water. All larval development occurs within the nest. The clutch size is small (fewer than 20 eggs), but he nonpigmented eggs are large. The hatchling tadpoles have large yolk sacs, which provide all their nourishment until they metamorphose and eave the foam nest.

This specialized mode of reproducion eliminates the problems related o aquatic development. The outside ayer of the nest becomes crusty, thus alleviating the potential problems of desiccation and terrestrial predators.

Fourteen species of frogs (genus *Eleutherodactylus*) deposit large, nonpigmented eggs in moist, secluded terrestrial or arboreal sites, usually amidst leaf litter, in and under ogs, and in bromeliads (mode 8). Development takes place within the egg capsule, resulting in the hatching of a miniature replica of the adult. The eggs have large quantities of yolk that provide nourishment for the entire development of the embryo. Hatchlings have a horny projection (called an "egg tooth") on the tip of the snout, which they use to rip through the jelly capsule during hatching. The egg tooth is shed soon after hatching.

Martha L. Crump

Eggs of Hemiphractus proboscideus *develop on the female's back and hatch as small replicas of the adult.*

These species are small (20–45 mm) and deposit few eggs (5 to 43). Because the free-swimming larval stage has been eliminated, these species are entirely independent of standing bodies of water. The eggs are subject to desiccation and terrestrial predators, however.

Martha L. Crump

Leaves shield the eggs of Hyla saryacuensis *from the harmful effects of direct sunlight.*

A totally aquatic species, *Pipa pipa*, has evolved extreme specializations for parental care. The eggs develop in pits, covered with skin, on the back of the female (mode 9). Incredible acrobatic behavior is used by these frogs in transferring the eggs from the cloaca to the dorsum of the female. The male grabs his mate in front of her hindlegs, and the pair then swim upward in a loop. The female releases the eggs at the top of the loop (when the pair are upside down); the eggs fall on the male's underside and are fertilized. As the pair continue swimming, the fertilized eggs fall onto the female's back. Her skin swells up around the eggs and encloses each one. All development takes place within the egg, and the tiny frogs eventually swim out of their individual pouches. The clutches are relatively small, and the eggs are large.

Martha L. Crump

Laying eggs on leaves does not eliminate predation. Eggs of Hyla triangulum *are eaten by snakes.*

There is also a terrestrial species at Santa Cecilia, *Hemiphractus proboscideus*, that has evolved specializations for parental care (mode 10). Eggs are carried on the back of the female in separate depressions. Again, the clutch size is small and the eggs are large. The eggs contain sufficient yolk to nourish the embryos throughout development. Development is direct; when the young hatch, they are miniature replicas of the adults. Hatchlings are carried about on the female's dorsum for awhile; the young have large, flat gills that adhere to the back of the female. By the provision of extensive parental care, the young of this species are protected from many hazards.

With so many different modes of reproduction, we can see how the available habitat is partitioned in different dimensions. Many species exhibit the generalized mode of depositing eggs directly into water and having aquatic larval development. But slightly more than half of the species in the Santa Cecilia frog community have evolved breeding specializations. These highly evolved reproductive modes are adaptive strategies in response to environmental pressures. No one mode is "perfect" but such a diversity allows for maximal coexistence, resulting in a species-rich fauna. ☐

Hyla punctata *of Trinidad lays its eggs in a standing body of water. This strategy results in high mortality due to water evaporation and predation. Consequently, this species lays a large number of eggs.*

O.S.F.; Bruce Coleman, Inc.

All photographs by Allen Rokach, except where otherwise noted.

Brooklyn's Hasidim

by Jerome R. Mintz

Exiled from their homes in Europe, these ultra-Orthodox Jews have reestablished their communities in New York and face their future with optimism

"The difference between Satmar hasidim and other Jews is this: Once when the time came to put the Torah [the Old Testament] back in the covering, it was too difficult to fit it in, and the man who was putting it in suggested that they cut the Torah to make it fit. Ridiculous? Of course. You have to cut the covering to shape. We will adjust our environment to fit the Torah and not the reverse."

This parable, told by the Satmarer Rebbe (leader) at a Friday night meal, epitomizes the attitudes of the most pietistic hasidic Jews living in the Williamsburg section of Brooklyn. The hasidim are ultra-Orthodox Jews who until World War II were the uneasy residents of the villages and ghettos of central and eastern Europe. Joel Leib (a pseudonym), a Satmar hasid who quoted his Rebbe's parable to me, is a Hungarian Jew who survived the final year of the war in a concentration camp. Today he is one of some 75,000 hasidic Jews who live in Brooklyn, New York.

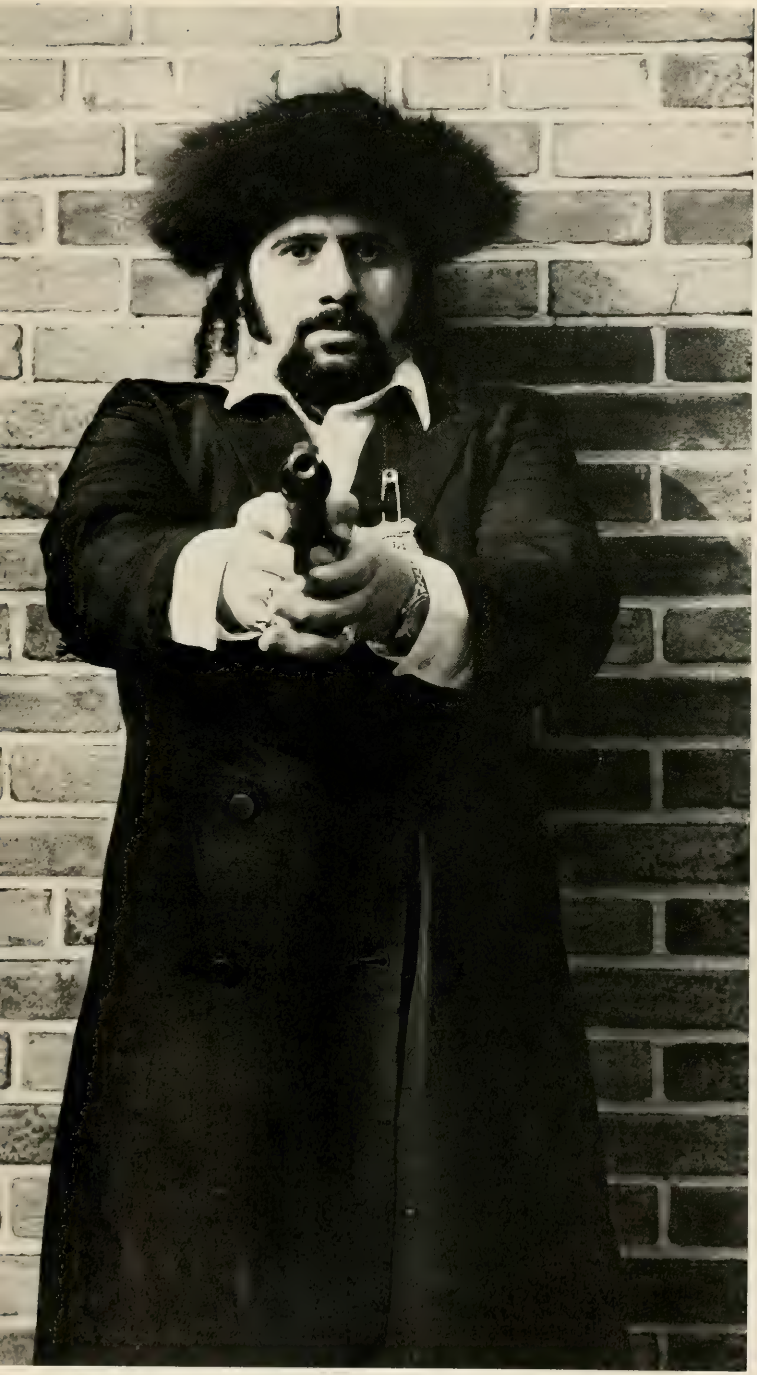
Leib's religion dominates his life, as it did in prewar Hungary, and his full beard and black caftan are outward signs of a complete allegiance to his faith. Early each morning and again just before nightfall he prays in the *besmedresh* (house of study), usually with the same quorum of at least ten men; during evenings after prayer, he studies the commentaries on the Torah with another small group.

His wife shares the daily rhythm of religious life, although women's activities are sharply separated from those of the men. Like most hasidic women, she rarely attends public services in the *besmedresh,* where she must sit in a screened balcony with the other women. The most evident signs of her religiosity are her efforts to maintain the ritual purity of her home, her attendance at the ritual bath after her menstrual cycle, her modestly cut, long-sleeved dresses, and the wig she wears to cover her closely shorn hair. Only the housing project where they live, the brownstone houses on the neighboring streets, and the elevated subway connecting Williamsburg to Manhattan testify that the hasidim have been transported to the New World and that their life has changed.

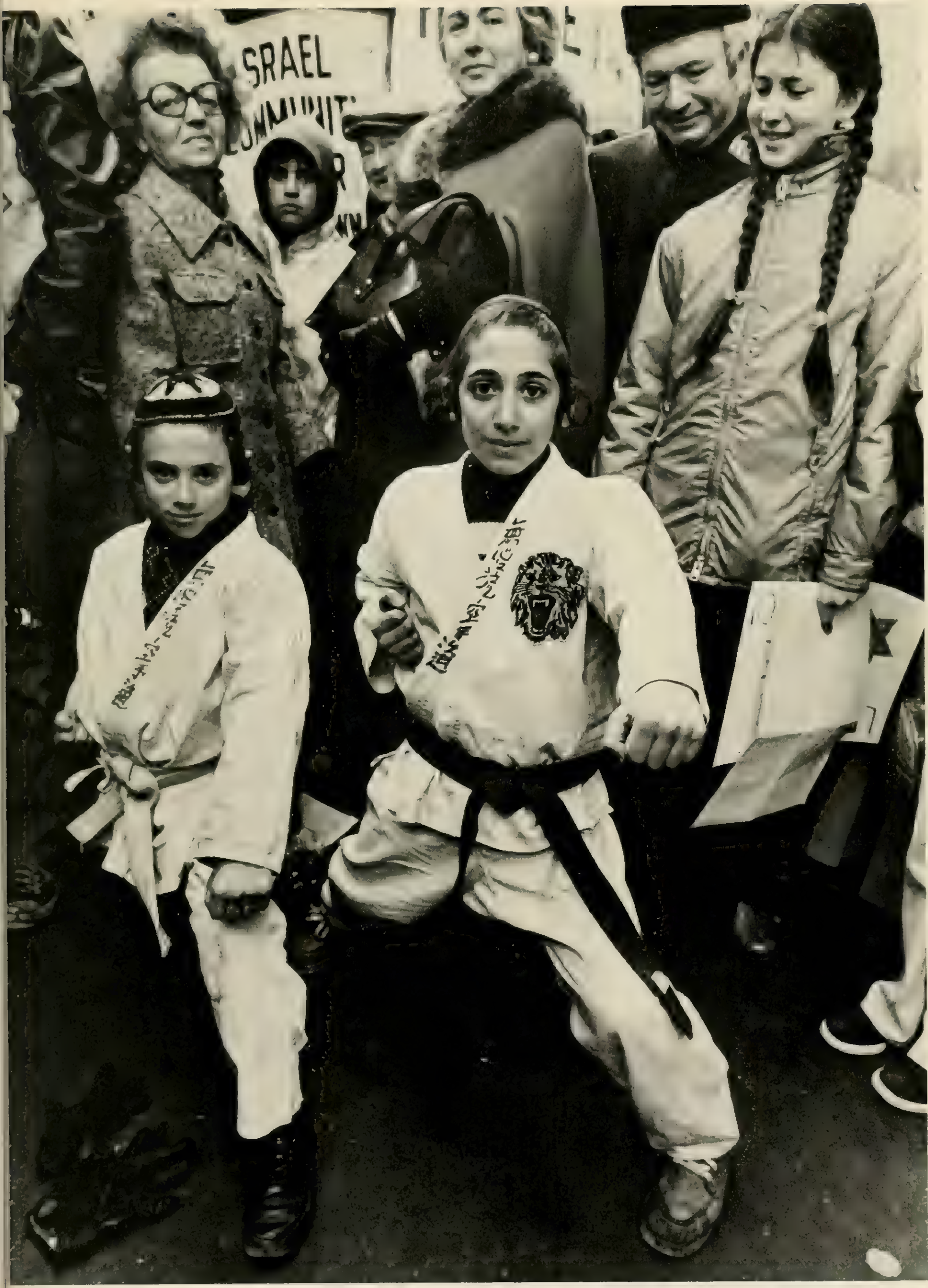
Most hasidim who immigrated here in earlier decades melted rapidly into the larger American Jewish community. Those who arrived in the postwar years, however, refuse to slip quietly into the surrounding society: they almost never intermarry, attend the theater, watch a movie or television, or seek advanced secular education. A large percentage work in the diamond and knit goods industries, while others work at jobs related to the community's religious needs, such as teaching at *yeshivas* (schools) or handling kosher food products.

The Brooklyn hasidic community's social and economic organization closely replicates that of the prewar eastern European villages where hasidic Rebbes and their courts were established. The Rebbes were the descendants of the disciples of the Baal-Shem-Tov and Rabbi Dov Baer, the two figures who initiated the hasidic movement in the mid-eighteenth century. The early hasidim separated themselves from established congregations and initiated a range of religious and social changes: the scholarly rabbi, who decided on questions of law, became subordinate to the inspired Rebbe; a more esoteric liturgy was substituted; prayer and devotion were intensified, and some rituals, such as visiting the ritual bath (a small pool, deep enough for one to completely immerse oneself while standing) were emphasized. As the disciples of the first hasidic leaders gathered their own followings, hasidic dynasties developed, with the Rebbes and their hasidim maintaining mutual loyalty in succeeding generations. The physical center of each group was the *hoyf,* or "court," a term that carried both the physical sense of the courtyard containing the Rebbe's residence, the house of study, the bathhouse, and the shops and storehouses, and the intrinsic dynastic qualities of inherited statuses and loyalties. Each court took its name from the town in which it was settled, for example, Satmar in Hungary, Lubavitch in Russia, Ger in Poland, Bobov in Galicia. Each was largely self-contained, with its own artisans, ritual slaughterers, shopkeepers, and an endless stream of visitors who sought the Rebbe's blessing, contributed financial support, and carried back to their villages tales of the miracles wrought by the Rebbe.

The various hasidic courts, which were once scattered throughout eastern Europe, are now located in this



An undercover detective dressed as a hasid.


SRAEL
COMMUNIT

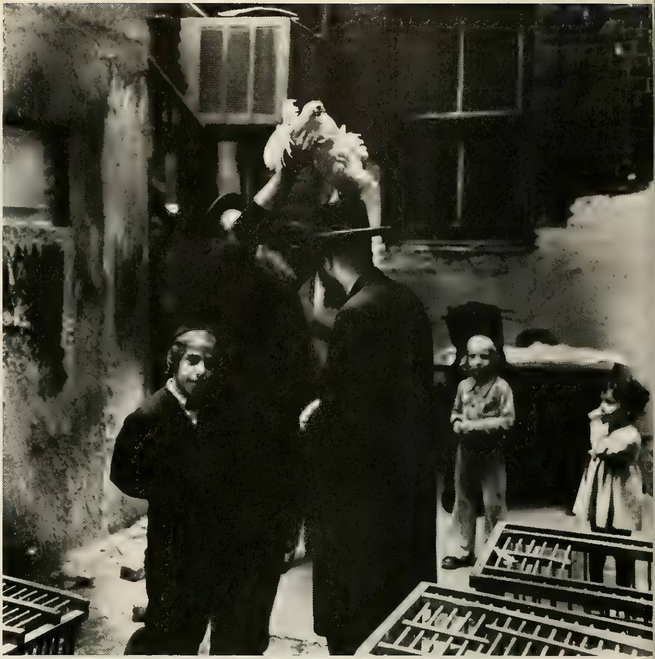
At a demonstration supporting Soviet Jews, hasidic children dress in karate robes to symbolize Jewish power.

country and in Israel. Here, they are concentrated in three Brooklyn neighborhoods—Williamsburg, Crown Heights, and Borough Park. Most hasidim in Williamsburg are of Hungarian origin and have allegiance to Satmar. The Russian hasidim of Lubavitch are settled in Crown Heights; while the growing community in Borough Park, comprising a range of courts of diverse geographic origins, is strongly influenced by its many American-born hasidim. Each court's size, which varies from fifty to several thousand families (for the Satmar community), is related to the number that survived the war, the percentage that preferred to settle in Israel, and the reputation of its Rebbe.

The strength of the present hasidic community derives in great measure from the intimacy and shared responsibilities within the courts. Each court is attached to a particular Rebbe and bound by special customs and traditions and a common language. Its followers have a shared point of view regarding religious and political matters and an oral literature concerning its Rebbes from the past to the present. Each court maintains its own *yeshiva* and *besmedresh* which are supported by tuition and voluntary contributions, generally 10 to 20 percent of every household's income. The duties and shared obligations develop strong, self-perpetuating bonds, with the sons assuming the loyalties and responsibilities of their fathers.

Like all Orthodox Jews, the hasidim are regulated by the 613 commandments (*mitsves*) of the Old Testament and by the elaborations of rabbinical interpretation. The *mitsves* embrace every area of human activity and are the moral and legal guides for daily life. Each Jew's personal fate, as well as the destiny of the community, is believed to hinge on the fulfillment of the laws. The hasidim, more fervent and punctilious than other Orthodox Jews, are considered to be zealots of the law.

In accordance with the most pervasive commandments, the hasidim honor the Sabbath (*Shabbes*) and the holy days, pray three times each day, bind phylacteries (*tefillin*) to the forehead and arm each morning, eat only kosher food, and use separate kitch-



Prior to Yom Kippur, hasidim ritually transfer their sins to chickens.

enware for milk products and for meat.

The Sabbath is divinely mandated and its observance is public and communal. From Friday sundown until Saturday night all work comes to a halt and a sense of solemnity and celebration descends over the neighborhoods. On Friday afternoon Joel and his fellow hasidim return home early from work. The shops close on the avenue and cars and trucks are parked, except for those of outsiders who pass through the quiet streets. The men come to the basement of the *besmedresh* where they step into the ritual bath to purify themselves in honor of the holy *Shabbes*. They wear silk caftans, and those who are married wear round fur hats with twelve spokes of fur. It is an emulation of the dress of the nobility of two centuries ago, now worn in celebration of the holy day and as a symbol of the hasidim's exalted state. That night and the following day are times for intense prayer, for periods of study, for visiting, strolling, and for meeting with the Rebbe and the court.

During the *Shabbes* the men con-

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gregate three times for communal meals. The hasidim are famous for the third meal, which takes place late Saturday afternoon. The Rebbe, dressed in a resplendent robe and fur hat, is seated at a long table; at the table are learned rabbis and illustrious members of the court. A newly married hasid has the seat of honor next to the Rebbe. The rest of the followers crowd before the table, those in the rear standing on benches, to observe the smallest motion of their Rebbe, be it lifting his spoon or stroking his beard. Individual hasidim catch the Rebbe's eye and toast him with a glass of brandy or beer and, in return, receive his blessing. The Rebbe is customarily served large platters of food—fish, chicken, bread, and soup—but he eats sparingly from the portions. The remains of each dish are then divided into small pieces and passed out to the hasidim, with the Rebbe or his assistant designating the recipient. The tidbits that the hasidim receive are not meant to satisfy their appetite; rather, the morsels enable them to share in the Rebbe's holiness and power. Most of the food is divided in an orderly way, but there are moments when the desire to partake results in chaotic scrambling. The food is passed among the followers until everyone has tasted it or until the supply is exhausted.

After the meal, in the growing darkness, the Rebbe says *toyreh,* his teachings. His talk is often set in mystical terms intertwined with biblical and talmudic allusions. At times, the Rebbe presents his thoughts as if in a semitrance, interweaving examples from the past with problems of the present. He may urge his followers to worship with fervor or insist that they preserve every vestige of the past as a shield—or he may warn his followers against riding the subway during rush hour when contact with women is unavoidable. Often the Rebbe's *toyreh* concludes with the prayer for the coming of the Messiah.

The laws are the primary factor in the development of the hasidic ethos. Fear of contamination through purposeful or accidental failure to carry out the *mitsves* helps create a pervasive anxiety that begins early in life. At the age of two, children are taught to make a blessing when they awaken

and before each meal. When young men reach sufficient maturity to be present at the Rebbe's table to listen to his teachings, each is certain that he is being directly addressed.

The tensions in fulfilling the laws would be insupportable if they were not introduced gently and balanced by the acceptance of human frailty and by the warmth and affection that are characteristic of hasidic life. Hasidic children play in the heart of the *besmedresh,* sometimes disturbing prayers and spilling over into the corridors and offices. For children, the house of study is their playground; for adults, it is the center of their lives. Among many of the most dedicated hasidim the religious law is compensated by sympathy and understanding for the problems of young people.

Although every hasid is observant of the laws, the Rebbe's zeal and insight are considered to be on a different scale from that of other hasidim. As a Lubavitcher hasid described it, the Rebbe "worships God every second of the day with all his heart and soul." Because of his prayer, his piety, and his family lineage, the Rebbe is thought to be in contact with enormous spiritual power.

Despite his importance in the community, the Rebbe is not lost to the individual hasid. Several times each week the Lubavitcher Rebbe remains in his office throughout the night to receive individual hasidim who come for his blessing or for his counsel. Although the Satmar Rebbe is 89 years old, he still receives his followers individually at his retreat in Belle Harbor, New York. The Lubavitcher Rebbe is celebrated for stimulating Orthodoxy among less religious Jews, and the Satmar Rebbe is known for his fierce determination to maintain every vestige of law and custom and for his opposition to the government of Israel. Notwithstanding their general fame and public responsibilities, the Rebbes' personal relationships with their hasidim are crucial for the maintenance of their courts.

Hasidim approach their Rebbe with a wide range of motives and needs. Some come for compassion, others require advice or a blessing, and some seek a miracle. They petition their Rebbe to help them overcome an illness in the family, the conflicts in a bad marriage, the curse of poverty and ill-fortune. To fend off potential danger, the Rebbes are also asked to decide on and to bless any family affair or business venture. A hasid will rarely make an important decision or pass through a crisis without visiting the Rebbe to ask for his blessing.

While its Rebbe provides a spiritual center of gravity, a court also requires legal, administrative, and practical organization. These are tasks not usually expected of the Rebbe, whose otherworldliness and spiritual stature generally remove him from the administration of mundane affairs. Orthodox Jewry has always maintained its own legal system to resolve such matters as divorce, contracts, and torts, and it is customary for the Rebbe to designate rabbis who decide such issues. The Rebbe also customarily names a committee of rabbis and learned laymen to administer the *besmedresh,* the *yeshiva,* and the ritual bath.

Despite the intense faith and strong traditions of the hasidim, the community would not flourish without new

orms of organization. Survival for ach court now depends upon reponses to problems involving neighorhood relations, jobs, housing, and overnment agencies. Today the ebbe must name men with wide ractical experience as court managrs to match the needs of the commuity with the ways of the modern vorld. With the help of "culture rokers" within the community, the asidim have used the techniques of ontemporary society to perpetuate nd strengthen their community.

The Satmar court, for example, ow has community services that inlude a private school system for nore than 5,000 children, a weekly ewspaper, an interest-free loan serve, summer camps, an employment gency, a bus service linking orough Park and Williamsburg, and ommunity butcher shops whose rofits support the *yeshivas*. The ourt also operates a medical and denal clinic, a pharmacy, and an emerency first aid and ambulance serve. There is a new *besmedresh,* vhich holds more than 7,000 people, s well as a new ritual bathhouse for he women. To meet the housing eeds of its growing population, the ourt purchased several hundred cres in Monroe Township, New York, where it will build a satellite ommunity and develop local inlustry and job opportunities. One uch community is already flourishng in nearby Monsey. To meet the oss of jobs in New York City due to he recession in the knitting and dianond industries, the Satmar hasidim ave obtained federal aid to initiate rograms to retrain unemployed hasilim as mechanics, machine repairnen, computer programmers, bookeepers, and secretaries—after first ssuring the Rebbe that these types of mployment would not conflict with Orthodox responsibilities.

Because of the size and unity of heir court, the Satmar hasidim have ecome an important voting bloc in heir neighborhood and district. In 1972 they voted to defeat Allard Lowenstein's bid for John Rooney's ongressional seat because of their inerest in government support for parohial schools. Their voting power, owever, was dealt a sharp blow in 1974 when the New York State reaportionment plan redrew state senate and assembly districts, thereby dividing the 35,000 hasidim in Williamsburg into two districts.

The hasidim do not object to their community being the minority in a nonwhite voting district, but they oppose having their community divided. They have brought suit in federal court, contending that the redistricting minimizes their voting strength and denies them their constitutional rights to equal protection and due process as hasidim and as white voters. The Supreme Court has agreed to hear what promises to be a landmark case in the determination of racial and ethnic prerogatives.

The hasidim are threatened by internal as well as external change. The growing hasidic population has resulted in greater geographic spread; as a consequence, social controls within the courts have been weakened. Some hasidim have expressed

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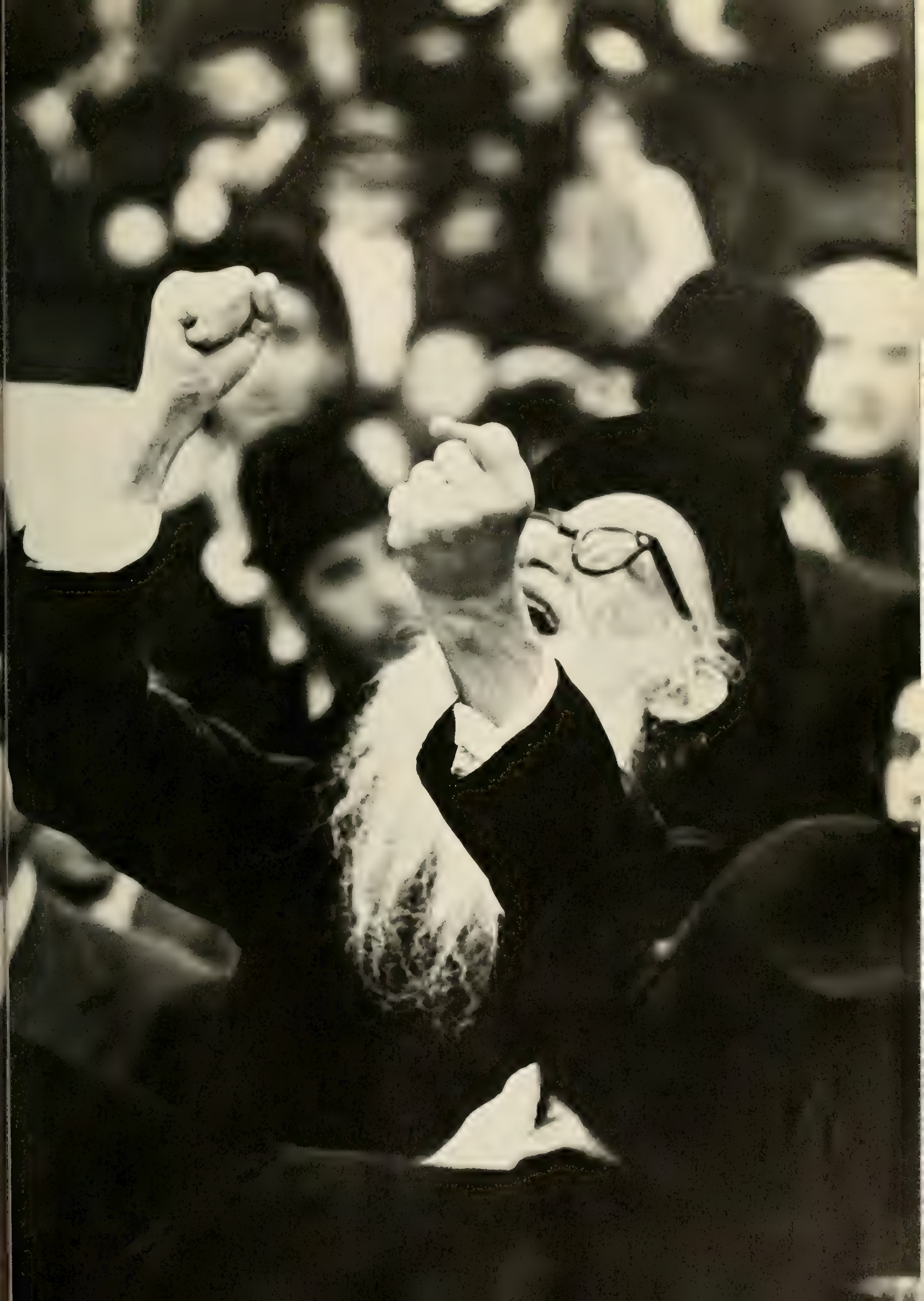
distress over the contrast between the appearance of religiosity and true piety. They distinguish between the *frum* (observant) who obey the basic tenets of Orthodox Judaism, and the *ehrlicher* (honest) hasid whose piety requires him to do more than the law requires.

With their continued zeal, the hasidim are not likely to discard their Orthodox traditions as did earlier immigrants. Rather, there is the likelihood of dramatic counterreactions. These might take forms already seen in hasidim—revitalized leadership and a more intense perception of Orthodoxy. The most immediate threat to the hasidim, however, is the advanced age of their most distinguished leaders. When a Rebbe dies, his place is usually taken by his son, although leadership can fall to a son-in-law, a grandson, or a devoted disciple.

The process of determining succession often intensifies conflicts between factions and can result in a court's division or dissolution. In the stress of selecting a Rebbe, differences resulting from geographic distance, size, or ideology may become exacerbated. The fracturing of an overextended court can mean survival for the faction that chooses wisely and dispersion for the one that does not. For this reason, the maintenance of the court is uppermost in the minds of the hasidim when a new Rebbe must be named. They must choose as heir someone who will enable the court to continue. With the death of the Stoliner Rebbe in 1955, his followers in Israel chose to follow an established Rebbe there, while those in this country decided to wait for the Rebbe's infant grandson to grow up. Since that time, the faction in Israel has dwindled. In Brooklyn, however, the court has grown. The grandson, now the Rebbe, is twenty-two years old and has been married to his first cousin for one year. He keeps an office in his parents' home in Borough Park. Young and untested, the Rebbe must still prove himself as a leader and teacher, but his presence has enabled the Brooklyn court to remain intact.

The problem of leadership may not be so easy to solve for the Lubavitch and Satmar courts, whose Rebbes are old and without direct heirs. For the hasidim, however, tragedy has supernatural ramifications portending messianic redemption. It signals the culmination of a great design. Expressing his faith, Joel Leib says: "In the darkest hour the Messiah will come." It is this devotion to their mystical and social heritage, together with their loyalty to the law and to their leaders, that enables the hasidim to flourish in twentieth-century New York. ☐



The Great Stone Faces

by Mark D. Coburn

Trying to carve up Mount Rushmore today would cause a national outcry

If the notion of carving gigantic presidential heads on Mount Rushmore were initiated today instead of during the 1920s, it would not stand a chance. Imagine, if you will, the story of the creation of the Shrine of Democracy moved half a century into the future, and the unlikelihood of the heads being carved will be immediately apparent.

In December 1923, Doane Robinson, secretary and superintendent of the State Historical Society of South Dakota, began to act on a brainstorm. He approached an old acquaintance, the widely respected United States Senator Peter Norbeck, and proposed to him the staggering idea of hiring a monument sculptor to carve heroic figures somewhere amid the Black Hills. As the months passed, Norbeck was gradually won over by Robinson's reasonable contention that patriotic statuary on a scale larger than that of the Sphinx would draw national attention and tourist dollars to South Dakota. Encouraged by Norbeck, Robinson, in August 1924, broached his scheme to the famous sculptor Gutzon Borglum. The idea promptly aroused Borglum's fervent enthusiasm, and the following month he made his first site-searching trip. By March 3, 1925, Norbeck and Rep. William Williamson had easily pushed through federal legislation permitting a mountain sculpture in Harney National Forest. A corresponding bill in the state legislature faced considerably stiffer opposition (mainly on financial grounds), but by March 5, it too had passed. On August 10, 1927, President Coolidge dedicated the project, and two months later drilling began in earnest.

Transport Robinson's inspiration to our own day and the results are easy to predict. The Sierra Club and Friends of the Earth would be among the best known of the dozen or more conservationist organizations that would immediately launch protests. Such periodicals as *Natural History* and *Audubon* would hasten to throw their weight into the battle. Post-Bicentennial enthusiasm notwithstanding, for every thousand letters that would pour into Washington, D.C., or Pierre, South Dakota, voicing patriotic approval of the proposed monument there would likely be ten thousand condemning the plan. The public and its elected representatives would be thunderously reminded that the national forests exist to preserve the natural beauty of our landscape, not to shelter men busily engaged in transforming awesome summits into George Washington's wig or Teddy Roosevelt's mustache.

The objections that would overwhelm the Mount Rushmore Memorial today, then, would likely be primarily a blend of ecological and esthetic concepts. Opponents would argue that the project and the crowds it would draw would mar the environment and that statues are less beautiful than the untouched terrain. During the seventeen years that passed between Doane Robinson's first inspiration and the end of sculpting at Mount Rushmore, in October 1941, these objections were raised, but the protesting voice was merely a whisper in comparison to the national shout we would hear today. Two other kinds of objections to Borglum's endeavors came far closer to stopping the memorial.

The first obstacle, and by far the most important, was economic. In large part, the history of the Mount Rushmore Memorial is a story of the struggle for funding. From Robinson's first battle to induce regional businessmen to pay for Borglum visit to the Black Hills until the fin congressional appropriation for car ing the mountain, in August 1940, th dollars were painfully hard to com by. The various Rushmore commi sions and other friends of the proje did yeoman work to obtain every cen of the $989,992.32 the monument finally cost. Had the general mood o the New Deal years not favored larg public projects, the depression woul probably have brought Borglum' work to a stop. A $50,000 appropriation for the monument, from grant made to South Dakota by th Reconstruction Finance Corporatio in the waning days of the Hoover administration, was the first real turnin point for Mount Rushmore. Until th end, though, there were alway enough congressmen and other opponents who agreed with Rep. T. L Moritz of Pennsylvania when he asserted that the statuary was a poor bu because "you cannot eat art." No did the numerous delays in the worl particularly endear the undertaking t Congress. It seemed as if each yea Borglum needed funds for just on additional year.

South Dakota Tourism Development

Second, the sculptor's personalit

and reputation led many in Washington and South Dakota to question his ability to bring the memorial to completion within a reasonable time and at a reasonable cost. On balance, Gutzon Borglum over the years did more to harm Mount Rushmore than to help it when he directed his considerable energies to fund raising and administrative problems. On the positive side, Borglum was a superb publicist with a Barnum-like flair for ballyhooing his work. He had many wealthy and influential friends and, for the most part, was deft at keeping them working for him. Further, his own profound enthusiasm for his labors at Mount Rushmore and his deeply felt belief that he was creating something of enormous patriotic and artistic importance were infectious. Whenever Borglum spoke or wrote about his presidents he made converts. On the other hand, his lack of financial acumen, his desire to be project administrator as well as artist, his belligerence, and his self-righteousness did much to retard the work and to weaken the monument's cause in Washington. Borglum's sense of mission too often tended to make him behave autocratically and abruptly at just those times when circumstances called for political finesse, willingness to compromise, and patience for treading calmly through jungles of red tape.

Those disturbed by the havoc that might be wrought by Borglum's "artistic temperament" found ample justification for their fears in the story of his involvement with the abandoned Confederate Memorial at Stone Mountain, Georgia. In 1925, with a decade of planning and nearly two years of full-time carving behind him, Gutzon Borglum had walked away from his work in response to a stormy disagreement with the Stone Mountain Memorial Association. Further, he destroyed his models (no longer his, but rather *their* property, claimed the association), and was forced to flee from the Georgia police and to seek sanctuary in North Carolina. Dispassionate examination of the evidence suggests that the sculptor was more sinned against than sinning. His assistant, Jesse Tucker, swore to Borglum that representatives of the association, disturbed by what they deemed Borglum's extravagance, had approached Tucker in his chief's absence and tried to get him to consent to finish the monument from Borglum's models after they fired him.

South Dakota Tourism Development

But such explanations seldom catch up with the headlined stories. No matter that dozens of completed Borglum statues and paintings graced homes, museums, and public buildings in America and Europe (including a fine head of Lincoln in the Capitol rotunda)—by late February 1925, Borglum, inevitably, was best known to the public as the man who had abandoned an elaborate mountain memorial with little more than one head completed. To further diminish confidence in Borglum, when word of the Mount Rushmore project became public, a Georgia group began saturating both South Dakota and Washington with a pamphlet denouncing him.

While economic crises and Borglum-centered problems several times came close to bringing a permanent halt to the blasting and chipping in the Black Hills, a further ground for opposition never became much more than a footnote to the Rushmore saga. Over the years there were sporadic, indignant complaints from groups that seemingly approved of the general concept of a national mountain memorial, but sharply disagreed with the choice of Washington, Jefferson, Lincoln, and Theodore Roosevelt as the sole Americans worthy of immortality through petrifaction. Borglum repeatedly explained the symbolic significance of the men he had chosen. The memorial, he asserted, was less a monument to four particular presidents than a celebration of certain basic themes of American history and culture: Washington stood for independence and the founding of the new nation; Jefferson's presence recalled government by the people and the first great era of expansion; Lincoln symbolized the preservation of the Union; and Theodore Roosevelt represented the importance of the West in our history and, through his association with the Panama Canal, "the completion of the dream of Columbus." But such explanations cut little ice with Teddy's niece Eleanor. Mrs. Roosevelt strongly advocated including the head of Susan B. Anthony, a plea supported in a 1939 resolution by the National Federation of Business and Professional Women. Nor did Borglum's explanations wholly stifle those Democrats who felt that if modern presidents were to be included, a granite Wilson was needed to balance the rocky Republicanism of T.R.

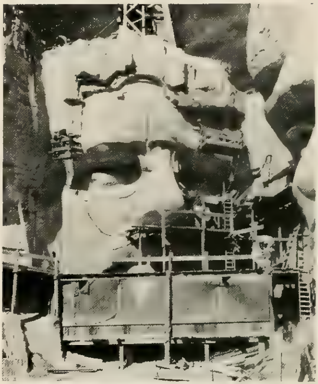
Although in our day they may seem the most germane possible objections to the Shrine of Democracy, ecological and esthetic condemnations of the Mount Rushmore Memorial never came close to threatening the monument's completion. Quite simply, the conservationist view of Borglum's efforts drew relatively little press coverage. Rather, the numerous journalists who commented on the actual carving process were inclined to revel in the statuary's scope and the skill with which the mountain was being devastated. Their prose usually reflected that sense of wonder before the colossal that Borglum himself considered to be so typically American and, hence, one more justification for creating such gargantuan heads in the first place. Most of the newspaper and magazine stories dwelt with awe on the dimensions of the heads, on the engineering problems involved in "carving with dynamite" and in transferring human features from model to mountain, and on geologists' speculations concerning how long the carvings might endure. The journalists' typical slant implied conviction that their readers were more likely to view Borglum's opus as a fine example of American know-how than as aggression against nature. Pictures more often showed how many men could stand in Lincoln's eye or on Jefferson's lip than the rock heap accumulating beneath the presidents or the trees that were chopped down to clear roadways to the peak.

Nor, of course, did the few art critics who spoke out have a chance of convincing the general public that a great engineering feat was not necessarily a great esthetic achievement. And who but the avant-garde cared in the least that Borglum's naturalism was more than slightly passé in the age of Matisse and Picasso?

Usually the ecological and esthetic strands of criticism fused, with the objectors regarding the presidential heads as unlovely *because* they were unnatural. While such criticisms proved ineffective, their modern tone makes some of them stimulating reading today.

Cora B. Johnson, editorial writer for the *Hot Springs* (South Dakota) *Star,* was prominent among the early critics. She attacked the monument even before Mount Rushmore was selected, when the most likely site for the statuary was reported to be a group of Black Hills spires called the Needles. Said Mrs. Johnson in one of her outspoken attacks: "We view with alarm Doane Robinson's proposal to carve the Needles into statues. Man makes statues but God made the Needles. Let them alone."

Perhaps the most eloquent opponent of the shrine, if a rather tardy one, was a South Carolinian named Ernst Bacon, whose letter to the *New York Times* appeared in March of 1940, some eighteen months before work on the memorial reached its present state of completion. "I believe there are many people in America," said Mr. Bacon,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> who do not admire this type of mutilation of the noble outlines of mountains.
>
> There may be some who think that the motive behind such a work is not to make a monument for the Confederacy, as at Stone Mountain, or for the great Presidents of America, as the Rushmore.
>
> Stone Mountain is an extraordinary phenomenon. . . .
>
> On its most precipitous slope, where the curvature of the rock is certainly most interesting, Mr. Borglum chose to blast out huge quantities of rock, leaving an enormous pile of detritus underneath and exposing the inner rock, which is white by comparison to a beautiful weathered gray on the natural surface.
>
> In looking over your pictures of Rushmore Mountain before Mr. Borglum went to work there, I have the impression of an extraordinary rock formation being rendered offensive to the eye through this work which is supposed to be art. . . .
>
> We wonder who is served by these gigantic monuments, and the speculation arises as to how far we will yet go toward destroying that which is natural because we must put the trade marks of what we like to think of as our civilization in its place.

In the next few days the *Times* received two responses to Bacon's letter, both strongly supporting him. One writer brooded on "how long it would take Nature to obliterate the desecration." The other, like Mrs. Johnson fifteen years earlier, asserted that "most people prefer mountains the way God made them."

Some of Borglum's favorite ways of describing his esthetic intentions were tacit responses to criticism of this sort. He enjoyed turning one of his opponents' pet words against them by referring to his work as "natural." The explanation he gave to an interviewer in 1927 is typical of that strain of Borglum's "logic":

> Sculptured work on a mountain must belong to the mountains as a natural part of it [*sic*]; otherwise it becomes a hideous, mechanical application.
>
> A simple inscription upon the broad face of the mountain, for instance, is much nobler and more natural than if that inscription has a line or border around it.

Precisely *why* the 36-inch-high gilded letters in which Borglum originally intended to carve a brief history of the United States around the corner from the four heads would be "natural," while a border of, say, stars, stripes, and eagles would not be—that the artist never quite made clear.

Another way in which Borglum implicitly justified the naturalness of his work was his dramatic habit of asserting that the essence of the presidential heads had always been a part of Mount Rushmore, and therefore the sculptor's great task was to "free" those heads from the surrounding stone. Such comments as the following are pure Borglum: "Washington still lies behind the granite." The rock must be "relieved

. from the head." "The brow [of
ashington] has emerged, amazing
mass, vigor and beauty of form
. the great face seemed to belong
the mountain; it took on the ele-
ental courage of the rocks surround-
g it." "[I must] try to find and re-
ise the faces of four great Ameri-
ns within that granite mountain."
Caught up in Borglum's elo-
ence, perhaps his audiences never
ked themselves why the heads of
ister Keaton and Jack Dempsey
uld not equally well be "released"
om the Black Hills granite. Even

illette, Photo Researchers

anklin D. Roosevelt, in an im-
omptu speech at the dedication of
fferson's head, found himself echo-
g Borglum's phraseology. The
onument, he said, "exemplifies . . .
operation with nature and not fight-
g with nature."

The same people who had difficulty
garding mountain sculpture as an
t of cooperation with nature often
iced yet another concern—that
one Mountain (if ever completed)
d Mount Rushmore would become
ecedents. The *New York Times* let-
r writer who wanted peaks "the
ay God made them" ended her
mments with a paragraph that took
is other tack: "Rather lucky,
n't it, that the rock formation of the
alisades does not lend itself to sculp-
re? Otherwise we might have a
ring of Mayors along its entire face
view from the Henry Hudson Park-
ay."

The comic possibilities of a spread-
g taste for mountains with noses
ere not lost on the media (nor did
ushmore itself escape the cartoonists and other humorists unscathed), but one hears a note of real concern beneath even such crude wit as that of this bit of doggerel from the *Chicago Tribune:*

> O Gutzon Borglum, have a heart
> Spare just one mountain top
> Leave one, I beg, just one at
> least
> That you won't chop and chop.
> You cruise around with dynamite
> And drills and tools and gears;
> And carve up some grand mountain
> That has stood ten thousand years.
> A mountain fills me full of awe
> I only gaze—and gulp
> But to you, Gutzon, a mountain is—
> Just something more to sculp . . .
> No longer can I feel alone
> As mountain trail I plod;
> The great stone faces all around
> Make me think I'm in a mob.
> I shriek for solitude and turn—
> And run and run and run
> At last an unspoiled peak I see,
> Oh, Gosh! it's Jefferson.
> I'd rather see a mountain
> Just as it's always been
> Than after it's been all
> dolled up
> With whiskers and nose and
> chin. . . .

The columnist in *The Nation* who signed himself "the Drifter" made the point with greater deftness. After opening with some gentle digs at the pretentiousness of carving on a massive scale with dynamite as the chief tool, he reflected on the potential spread of the custom:

> In time our financial wizards, seeking new ways of perpetuating their memory, will buy up any remaining available mountains and sit for a sculptor carrying a stick of dynamite in one hand and a match in the other. It is this prospect which fills the Drifter with despair. To come face to face with Washington or Lincoln along some remote mountain range would be at least bearable. But he cannot face the prospect of having to pitch his camp under the nose of Henry Ford.

Ironically, by the time work at the Mount Rushmore Memorial was concluded, some of those charged with the responsibility for it were finding themselves uncomfortably close to agreeing with the project's opponents. Higher officials of the National Park Service were becoming aware of the problems of land ethic involved in their anomalous position. How could an organization charged with the duty of preserving large portions of the wilderness justify administering a project whose goal necessitated decimating a wilderness peak?

In March 1941 (the same month Gutzon Borglum died and his son Lincoln took over supervision of the final stages of the work), Newton B. Drury, director of the National Park Service, appeared before a congressional subcommittee to plead for a small appropriation for maintaining Mount Rushmore Memorial the following year. When a congressman speculated that there might soon be requests for funds for new mountain statuary, Drury's reply was both emphatic and suggestive of weariness: "As far as I am concerned, I hope this will remain as it is now, unique, and the only one of its kind."

We could not easily legislate the Mount Rushmore Memorial out of existence, and certainly most Americans have no wish to do so. The Shrine of Democracy remains an engineering wonder, a patriotic treasure, a fact of American life. The conflicts over Borglum's work are history; the work itself is as immortal as any human creation can hope to be. The memorial, as Borglum often asserted, would seem to have a chance of surviving when virtually all other artifacts of our civilization have vanished. The passing years are making it clear, however, that like any other man-made object, the Mount Rushmore carvings reflect the era of their creation: although Borglum's presidents may endure half a million years, they are already dated. They reflect a love of the colossal and an assumption about man's right to overmaster nature more acceptable in the American 1920s and 1930s than in our own day. While future changes in artistic taste and in attitudes toward landscape may again make mountain sculpture seem worth attempting, it is improbable that Borglum's achievement will be matched in the years immediately ahead. Most of the hundreds of thousands who visit Mount Rushmore annually, however deeply moved they be, would likely share Drury's hope that the carvings remain unique. ☐

South Dakota Tourism Development

David Muench

Night Shift for Sloths and Other Sluggards

by G. Causey Whittow

Being slow of foot
is not a handicap
if you live in the trees
and come out after dark

Most mammals move quickly and may cover large areas to obtain the quantities of food they require. High body temperatures and metabolic rates are common features of such active animals. Some species, however, move only very slowly, and they are noted for their extremely sluggish behavior. Slow mammals that immediately come to mind are the sloths. The word *sloth* itself is derived from the Old English word for slow.

Slowness is not confined to the sloths; it is also characteristic of some prosimians, among the primates. Not all prosimians, however, are sluggish; in fact, some, such as bush babies, are extremely active. But the lorises of Southeast Asia and the pottos of Africa are slow moving by any standards. There are also slow species of marsupials, notably some of the phalangers of New Guinea and Australia.

Sluggishness has not developed as a specialized adaptation in only one order or family. Slow mammals, however, do have some features in common: they are all largely confined to the tropics and they are all both arboreal and nocturnal.

It might be argued that the tropical distribution of slow mammals points to their failure to survive in colder climates. The metabolic response of sloths to cold is defective, but the slow loris and potto are able to regulate their body temperatures at quite low air temperatures. The arboreal habitat of slow mammals might simply reflect the prevalence of rain forests in the tropics or the filling of an arboreal niche for reasons unconnected with being slow. Nevertheless, a slow mammal is probably exposed to fewer predators in the trees than on the ground. Furthermore, although many mammals are able to move rapidly through the trees, an arboreal life—as opposed to life on the ground—makes for relatively slow movement.

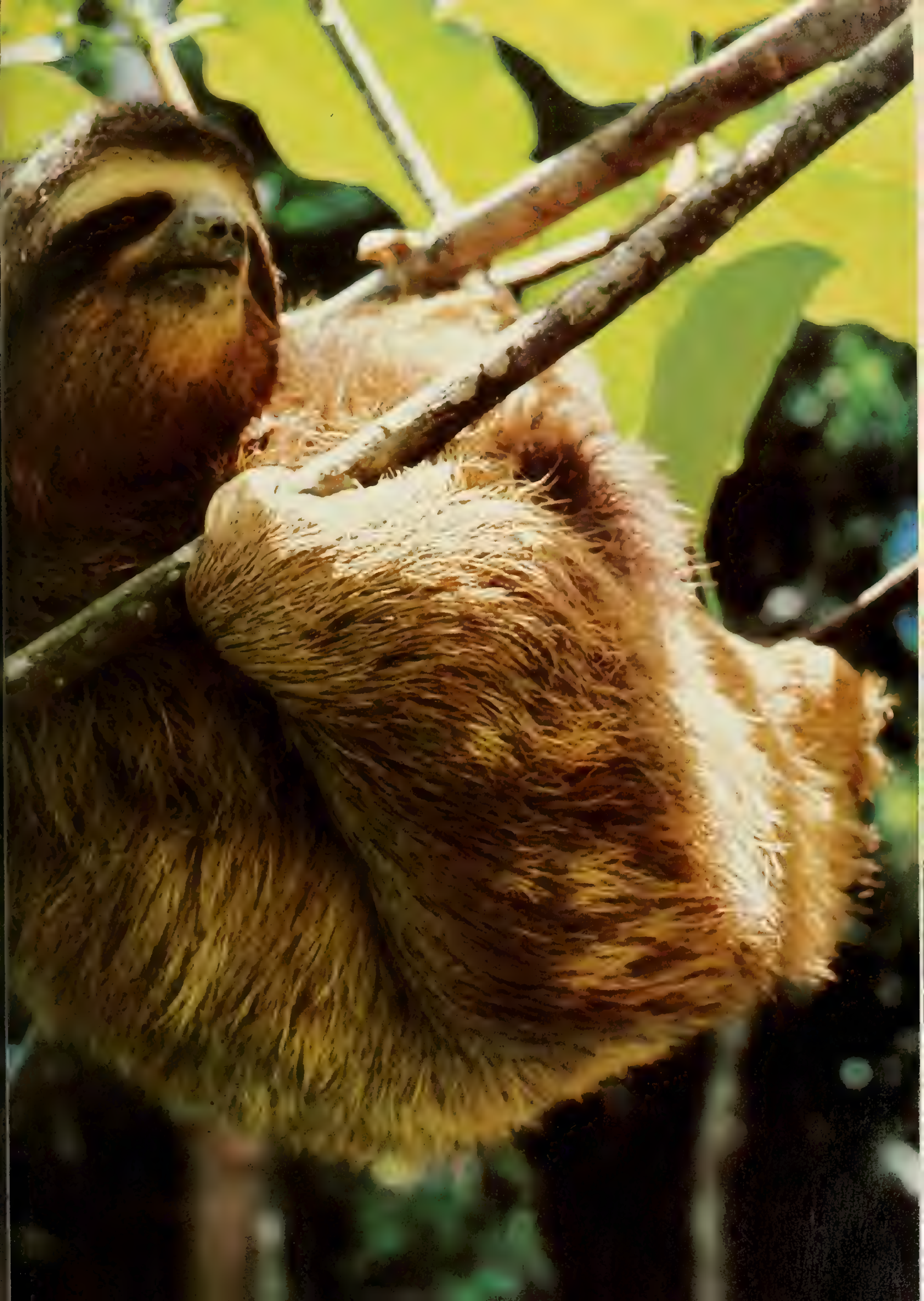
From a thermoregulatory point of view, it makes eminent sense for a sluggish mammal to be nocturnal. The animal produces the minimal amount of heat, by metabolism, during the warmer day when it sleeps, and it becomes active and thereby increases its heat production during the cooler night.

What are the advantages of slowness to a mammal? At first sight, a slow-moving animal would seem to be at the mercy of its predators. However, a slow-moving animal is less likely to attract the attention of a predator. By the same token, the prey of a slow mammal may not be aware that they are being preyed upon. I was able to verify this in Malaysia, watching a slow loris capture grasshoppers. First, the loris carefully examined a grasshopper from a distance; then moved forward at an even pace, its outstretched arms spaced wide apart. As it neared the prey, the loris gradually brought its hands together and clutched the grasshopper before the insect suspected its fate.

Another advantage of being slow is a reduced energy requirement. An inactive mammal expends less energy than an active one, and this would give it an advantage in times of food

Three-toed sloth

Richard B. Peacock; Photo Researchers



shortage. Slowness may also be regarded from the standpoint of niche separation. Some animals are arboreal and some terrestrial (spatial separation); others are diurnal or nocturnal (temporal separation). The spectrum of activity from the very slowest species to the fleetest of foot or wing results in different niches within a habitat, enabling more species to coexist in a given area.

Sluggishness in mammals is associated with an array of structural and functional divergences from the usual mammalian pattern. The most obvious of these is in the limbs. Sloths spend a great deal of their time hanging upside down from the branch of a tree, which, incidentally, virtually removes them from the grasp of many predators. Their digits terminate in huge hooked claws, which are effective structures for suspending the animal from a tree. The slow primates have relatively large hands and feet that are capable of a powerful sustained grip. Not so apparent, but also involving the limbs, are vascular structures called retia mirabilia. The main arteries and veins in the limbs break up into a network of many fine vessels in close apposition to one another. In the potto, the function of these structures may be to insure that blood continues to flow to and from the hands, feet, arms, and legs during the prolonged contraction of the muscles involved in gripping.

Low body temperature is a correlate of slowness in mammals. Rectal temperatures of the two-toed and three-toed sloths were found to be only 34.4° and 33.0°C, respectively, 3° to 4° below the values for most placental mammals. The body temperature of a potto is 2° to 3° below the expected value. I have found that the body temperature of a slow loris is 34.8° during the day and somewhat higher at night. Recent work by T.J. Dawson in Australia has shown that

Searching for a suitable resting spot, a cuscus inches through a network of fine branches in its New Guinea forest habitat. This slow-moving marsupial feeds mainly on fruits and leaves.

Jack Fields; Photo Researchers

body temperature of the cuscus is nilar. Low body temperature may a mechanism for conserving en- gy. To maintain a high body tem- rature requires additional food, ich would have to be obtained by pending energy in foraging.

Associated with the low body tem- rature in slow mammals is a very v metabolic rate. The metabolic e of sloths was found to be only 36 66 percent that of other mammals comparable body weight. The met- olic rate of the potto is 66 percent the standard for mammals. In the w loris, the metabolic rate during day was 36 percent of the usual ue for placental mammals. The gwantibo, an African relative of slow loris and potto, also has a v metabolic rate. The cuscus is ecially interesting in this regard, cause it is a slow marsupial. The tabolic rate of marsupials is gener- y about 70 percent that of placen- s; that of the cuscus is even lower, ly 83 percent of the predicted value marsupials.

The physiological basis of low tabolic rates in slow mammals is t clear. Sloths are deficient in body- oving skeletal muscle—a major at-producing tissue in most mam- als. In sloths, the total amount of scle constitutes only 25 percent of dy weight, approximately one half the proportion of muscle in other mmals. This might contribute to low metabolic rate. And an ani- l that spends a great deal of its time tionless does not require as much uscle. Sloths also have a low roid gland activity. A hypothyroid te would be consistent with a low tabolic rate because thyroid hor- nes are the main hormonal stimu- of an animal's metabolic activity.

A mammal that moves very slowly ed not necessarily have a low meta- lic rate while it is at rest. The speed movement during activity will obviously affect the metabolic rate, but it does not follow that there should be a difference between the metabolic rate of a sluggish animal and an animal that moves rapidly, when they are both at rest. Indeed, some very active and quick mammals have low metabolic rates at rest. Nevertheless, all slow mammals studied do have low metabolic rates—conceivably an adaptation to being sluggish. An animal that is inactive for a large part of its time, and then moves slowly when it is active, has a limited capacity to obtain food and energy. A low resting metabolism may reduce the animal's energy requirements to conform with its diminished feeding capabilities. According to this theory, the low metabolic rate of slow mammals is a consequence of their slowness.

Another possibility is that the low metabolic rate of slow mammals is an adaptation to a hot climate. All slow mammals are tropical animals, and in view of the difficulties of dissipating body heat in a warm, humid environment, it would be to their advantage to produce the minimal amount of heat by metabolism.

The acquisition of a low metabolic rate, and commensurately reduced energy requirements, might then have permitted these mammals to adopt a slow mode of progression and a life of considerable inactivity. In other words, the low metabolic rate might have been the key change that allowed mammals to occupy the niche of slowness. This hypothesis would conform with the finding that all slow mammals that have been investigated are hypometabolic, but not all hypometabolic mammals are slow. Seen in this light, the reduction of muscle tissue in sloths is probably a consequence of slowness rather than the underlying basis of the low metabolic rate. A species that uses its muscles very little will not require the muscle mass of an active animal.

Whatever the origins of a low metabolic rate in mammals, hypometabolism seems to have generated the development of a number of adaptive mechanisms. The retia mirabilia in the limbs may not only insure an adequate blood flow to the limbs during grasping but may also minimize heat loss to the environment. This is important to an animal that produces little heat, even in a tropical climate. The proximity of arteries and veins in the retia allows the rapid transfer of heat from the warm arterial blood to the cooler venous blood. Heat carried in the arteries, instead of being transported to the skin of the hands, feet, arms, and legs, and then lost to the surrounding air, is "short circuited" back to the heart via the veins and is thus retained by the body. This is a well-established function of the retia in the flippers, fins, and flukes of marine mammals, which face a formidable problem in the regulation of heat loss because of the enormous cooling power of water. In the sloths, the forelimbs are extremely long, and while this may be an adaptation to their unusual posture, it does increase the potential for heat loss and the need for structures such as the retia mirabilia, which attenuate cooling of the limbs.

In effect, the retia mirabilia serve to increase the thermal insulation of the tissues of slow mammals because they reduce heat transfer from heat-producing tissues to the environment. Another, more obvious way of preserving heat is a to acquire a thick coat of hair. The sloths, the slow primates, and the cuscus all have thick fur. The pioneer work of physiologist P. F. Scholander and his colleagues revealed that the thermal insulation of the sloth was greater than that of other tropical mammals. Sloth hair lies in a direction reverse to that of other mammals, presumably to facilitate the runoff of rainwater when they are hanging upside down. This would prevent their fur from becoming sodden and losing its insulative properties. (In some sloths, the growth of algae on the fur imparts a greenish tinge that may help conceal them from predators.)

Why do slow mammals need a thick coat and retia mirabilia if both serve the same purpose? The answer is that the limbs are usually not as well insulated with hair as the rest of the body. In addition, the limbs have a large surface area relative to their bulk and, in consequence, tend to cool rapidly. In fact, the physics of heat flow from slim, cylindrical structures such as the limbs determines that their hairy integument is ineffective as a thermal insulator.

An animal that starts the day with a low body temperature and meta-

slow loris will not release its
d hold until at least two of its
nbs have secured a new foothold.
is cautious mode of locomotion
less likely to alert prey
ch as perching insects.

zynski

bolic heat production, and which sleeps during the day, is both physiologically and behaviorally well adapted to a hot environment. Studies I have conducted revealed that the slow loris can also effectively dissipate heat by panting. This would enable the slow loris to tolerate conditions as hot as those it is ever likely to experience in the tree canopy, where solar radiation presents an added heat stress.

In the tropical rain forest, air temperatures in the tree canopy are low at night. In addition, an arboreal animal may lose body heat by radiation to the sky. Under such conditions, the animal's thermoregulatory problem is reversed. We found that the slow loris adjusts to these conditions by increasing its metabolic heat production. Its nocturnal activity produces additional heat, compensating for the increased heat loss to the cooler microclimate.

Slow mammals should show marked changes in their neuromuscular physiology. One investigator found that a sloth's muscles contract much more slowly than those of other mammals. In the potto, the rate of contraction of the limb muscles is intermediate between that of the "fast" muscles, which a cat uses for rapid movements, and that of the "slow" muscles, which are used in maintaining posture. But the speed of muscular contraction may not be the only factor responsible for slowness; the central nervous system may also be involved. A suggestion has been made that sloths have some features of a decerebrate animal—one in which the cerebral hemispheres of the brain have been removed or are not functional. This means that, for part of the time, the higher levels of the brain may not be exerting any influence on the control of breathing, muscle contraction, or other body function.

Passage of food through the gut is exceptionally slow in sloths. The animals defecate and empty their urinary bladder only at infrequent intervals. They often descend to the ground to do this, which may be the basis of their very simple social behavior. Normally solitary and inactive animals, the use by several individuals of the same spot for toilet purposes may be the mechanism by which they meet and breed. Although slowness of movement limits range, the widely circulated story that sloths (and lorises) live their entire lives in one tree is almost certainly untrue.

Slowness invites comparisons with the related phenomena of hibernation and estivation. These are torpid states characteristic of cold climates or periods of drought. Both hibernation and estivation result in a considerable reduction in the energy requirements of the animal and, appropriately, both states may often be induced by a curtailment of the animal's energy supply. However, these are periodic events in response to periodic variations in the environment. Slowness is a less drastic phenomenon and is a continuous state. In the equatorial rain forest, seasonal changes in temperature, rainfall, or food supply are minimal. It is intriguing to consider slowness as a less pronounced, tropical counterpart of true torpidity. In place of a phasic change in the physiology of the animal, correlated with a recurring change in the environment, there is a constant physiological (low metabolism) and behavioral (slowness) adaptive state, induced by exposure to the unchanging heat and humidity of the rain forest. Perhaps slow mammals are the most highly adapted mammals of the tropical rain forest, not only physiologically but also in terms of the energy demands that they make on the rain forest ecosystem.

The slow mammals are an enigma among a group of animals noted for their high body temperature and metabolic rate and for their activity. They deserve more study. Low metabolic states among mammals, particularly in primates, may help us understand how mammalian tissues may adapt to low metabolic levels. Such knowledge could have implications for space travel and for life in any environment where a reduced energy requirement would be an advantage.☐

Three-toed sloths travel, eat, sleep, mate, and even give birth while hanging upside down. All of these are done very slowly.

Robert C. Hermes; National Audubon Society

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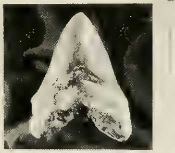

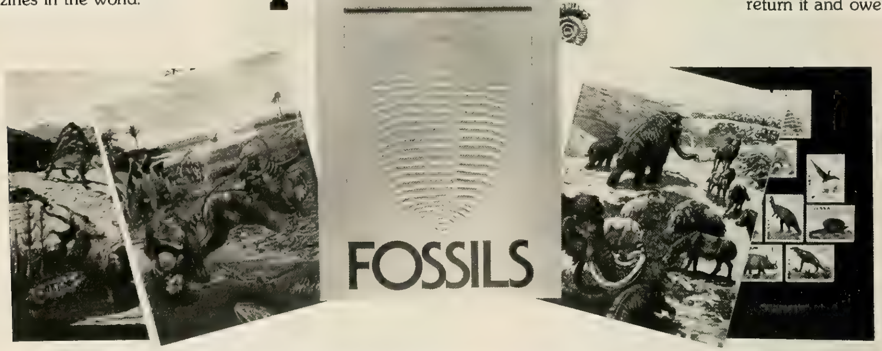

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by Raymond Sokolov

igh Torte

r alpine cooks,
king a cake is a
preme achievement

After a day or so, the body adjusts igh altitude, and we can begin to lk through a normal life without adaches, nausea, and a pounding rt. Cooking, however, remains a oblem. Low air pressure compli- es nearly all the processes of the chen. It slows down boiling and eds up deep frying. It throws sugar okery out of kilter, and it turns the king of breads and cakes into a ndishly unpredictable affair.

The alpine poltergeists begin to ddle with our meals as soon as we 2,500 feet above sea level. Sig- cant trouble settles in at 5,000 t, approximately the elevation of nver. And by the time we reach adville, Colorado, the nation's hest city (elevation 10,190), or adville's tiny neighbor, Climax, at 11,300 feet probably the loftiest settlement in the country, we have attained a height where it is all but impossible to cook beans in the conventional manner, where bread rises too quickly, and where a poached egg is an achievement.

Of all the pesky changes brought on by thin air, the most unsettling for sea-level natives is the lower boiling point of water. For most of us, 212°F is one of the basic benchmarks of life. It is certainly a crucial factor in cooking because it acts as an upper limit, a foolproof temperature ceiling for anything we might choose to cook in water. You simply can't heat water higher than 212° (unless you put it under artificial pressure). Above that limit, it turns to steam, bubbles away. At sea level, that is.

But, as the air pressure falls at significantly high altitudes, water will turn to vapor more easily. There is less air pushing down on the surface of the water, and so it can bubble up and away with less of a push from beneath, for example, at a lower temperature. This means that boiling will occur sooner, but that the boiling point—that crucial heat ceiling—will be proportionally lower. At 5,000 feet, water boils at 202.6°. At 10,000, the hottest it will get is 194°. At 14,000, water boils away in furious, giant bubbles at only 187.3°.

Consequently, when you put food into this "cool" boiling water, it cooks much more slowly than you might have expected. Bubbles or not, the heat is simply not there.

I tested this proposition last fall on the trail leading up Mount Whitney at the lower right-hand corner of the Sierra Nevada in eastern California. At approximately 12,000 feet, it took slightly more than six minutes to produce a "three-minute" egg. The white took that long to turn opaque. It was delicious, nonetheless. The egg had been purchased the day before when very fresh in Shoshone, California, near Death Valley, where it takes just *under* three minutes to

king a cake atop Mount Whitney, altitude 14,495 feet.

Raymond Sokolov

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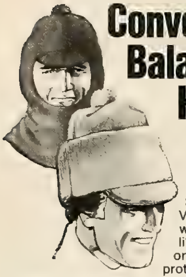

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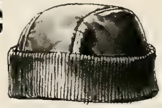

The Eddie Bauer Watch Cap is insulated with Bauer Goose Down to keep warmth in and chill out. Outside is Nylon taffeta treated to repel rain, snow and stains. Lining is a blend of dacron polyester and cotton. Nylon knit brim rolls down to protect forehead, neck and ears. Rolls up to pocket size. **Sizes:** S(6½-7), M(7⅛-7¼), L(7⅜-7½), XL(7⅝-8). **Colors:** Camouflage, Red, Black, Dark Green. **0135** Cap **$9.95** ppd.

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soft-boil eggs at 280 feet below sea level. But the altitude on the Whitney Trail had turned my stomach and taken away my appetite for eggs or anything else.

Even after fourteen hours of supine acclimatization in a small orange and blue tent bought for $10 at a bankruptcy sale, I was still slightly nauseated. But my body had adjusted enough to the air so that I was able to lace my boots and consider with some confidence the final stage of my assault on the highest peak in the contiguous United States. Whitney rises 14,495 feet. My job: bake a cake at the top.

I will spare you a step-by-step account of my heroic ascent over the last five miles of snow-covered trail, which zigzags skyward in a great, jagged bowl and then rounds a corner to the mountain's back slope, where, smack, the previously hidden entirety of the Sierra hits your glare-strained eyes. Stretching hugely away below are trees, peaks, valleys, and flashing monocle lakes.

Getting there is no great feat. Hundreds of Boy Scouts and sedentary marmot-lovers climb Whitney every summer. Baking a cake at fourteen and a half thousand feet, however, is a real accomplishment. Indeed, it may never have been attempted before, because altitude interferes more severely with cakes than it does with anything else in cookery. Even at relatively low elevations, trouble sets in. At a mere 3,000 feet, *The Joy of Cooking* warns us, cake doughs will begin to suffer "pixie-like variation that often defies general rules."

If you were to mix up a standard white cake dough and bake it in the usual way in your oven in Denver or Laramie, it would come out flat and dry. The dryness is caused by the low humidity of the mountain atmosphere, while the flatness is a result of the thin air, which defeats the best efforts of baking powder, beaten eggs, shortening, and sugar to hold air in the cake and keep it light.

Baking powder is a chemical raising agent in which an acid and an alkaline substance react, in the presence of moisture, to emit carbon dioxide. This gas forms small bubbles in a normal cake dough. The heat of baking then "sets" the cells formed in the dough by the bubbles. (Modern baking powders are double acting; they begin to act in cold dough, but they do not do most of their work until they are subjected to heat. This permits us to mix up a ba ter, then wait a while before using i

High altitude plays havoc with th chemistry. The gas has less air pre sure to work against, so it works to well. The batter puffs up and bubbl as if it were boiling. Then the ga escapes before the cells have set an the cake collapses. Other factors als contribute to the density of cakes high altitude. Sugar, in excess, pro duces a coarse, crumbly textur Beaten eggs are a source of unwante air. Butter and other shortenings als cause problems in air retention.

In other words, if we are to bak cake at high altitude, we must signif cantly alter the delicate balance of batter designed for use at sea leve And, indeed, if you look at mo cookbooks' baking sections, the present you with various rules o thumb for alpine cakemaking. A typ cal set of such instructions migh direct you to reduce the baking pow der in a conventional recipe by ⅛ t ¼ teaspoon per 1,000 feet of ris above sea level. It would also advis decreasing the sugar by ½ tablespoo per 1,000 feet, and the shortening b ½ teaspoon. Conversely, you wi sometimes be told to add extra flou say one tablespoon per cup in th original recipe, and extra liquid, tablespoon for every additional 2,50 feet of altitude above 5,000 feet.

I do not present these adjustmen as established principles. No on does, because different recipes tu out differently. Or, to speak frankl no one really knows precisely how adapt a specific recipe for high alt tude without trial and error. Norma cooking, it appears, is in many way a sea-level phenomenon, a trick tha works in one environment and not i others.

Prospectors and mountai climbers, for instance, long ag learned that above 10,000 feet the had to use pressure cookers to coo beans and other foods that requi long boiling even at the high tempera tures practicable at sea level. Sim larly, at alpine altitudes, the standar adjustments for cakes approach practical limit. If you continue to re duce the baking soda by decremen of ⅛ teaspoon per 1,000 feet, yo eventually reach a point at which yo must, following the rule, eliminat baking soda altogether from the rec ipe. For example, the 2 teaspoons baking soda called for in *The Joy Cooking*'s recipe for gold layer cak would have to be omitted in any ve

of the dessert prepared above
00 feet. This is, of course, a tech-
l possibility only in Alaska, the
halayas, and a few other extreme
ironments where cake baking is
perhaps, essential. I mention it
to emphasize the specialized na-
of cakes and the ingenious bal-
e of natural forces they represent.

t any rate, my own bid for a place
the *Guinness Book of World*
ords as history's highest baker
with fair success. Cooked for
ut 45 minutes in an Optimus Mini-
n (an aluminum torus sold in
ping equipment outlets) over a
ne burner's medium-high flame,
white cake (see recipe) emerged
much a cake. It was not the
y, convex ring one might have
lly wished for, but neither was it
cave and unacceptably dense.

nfortunately, I did not remain at
summit long enough to develop a
nal appetite, so for an assessment
he cake's taste, I had to depend
he opinion of the others present
devoured it before I had a chance
e it. I had intended to do so be-
se icing is essential for keeping
es moist for any length of time in
dry air at high elevations.

f I had stayed longer, I might also have verified certain other textbook nostrums about cooking in the upper reaches. As things stand, I am willing to take it on faith that above 2,500 feet, it is a good idea to compensate for dryness by covering prepared foods with aluminum foil and by using slightly less flour or more liquid in bread doughs (and watching carefully so that the more rapid action of yeast does not take you by surprise). I am also ready to believe that pressure cookers require an extra pound of pressure for every 2,000 feet above sea level and an increase of 5 percent in cooking time for every 1,000 feet above the first 2,000. And I will not hesitate, when next in Leadville, to add extra liquid to pancake batter or to consult a table of high-altitude temperature equivalents before attempting to cook sugar for candy or icing. All the usual stages, from soft ball to hard crack, occur sooner (at lower heats) the higher you go.

Finally, I take pleasure in advising the fast-food moguls that when they set up shop atop Pike's Peak, they will have the devil's own time serving crisp French fries. Even at relatively modest altitudes, the recommended frying temperature has to be reduced to about 355°, from the normal 375°, because the boiling point of the internal water in the potatoes is lower. Without lowering the fat temperature, you get external browning well before the inside has cooked. Presumably, at high enough altitudes, correcting for this anomaly will force French-fry vendors to lower their fat temperature to a point so low that it will seep into the potatoes and leave them as limp and greasy as some I once ate in a low dive in Austin, Texas. But that's another story for another time, when we have come down to earth. For the moment, my thoughts are still lofty, and I want to offer you the world's highest cake. The recipe is printed with ingredient quantities suitable for the summit of Mount Whitney.

Whitney White Cake

11½ tablespoons sugar
2 cups sifted cake flour
¼ teaspoon salt
¼ teaspoon baking powder
2½ tablespoons shortening, softened
1 cup milk
1 egg, unbeaten
1 teaspoon vanilla

1. Preheat oven to 400° or set up your camp stove.

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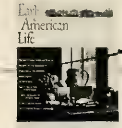

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CROWN

2. Mix together the sugar, flour, s and baking powder.
3. Beat the shortening and the m into the mixture from step 2. C tinue beating until the shorten has been smoothly incorporate
4. Now beat in the egg and the nilla and mix until smooth.
5. Turn into a greased, floured ni by-nine pan or into a simila prepared camper's oven. Bake conventional oven for 20 to minutes or for somewhat longe the camper's oven over medi heat. The cake is done when it l solidified and begun to pull aw from the sides of the pan.
6. Cool briefly and turn out ont rack or other clean surface.

Yield: one nine-inch cake

Note: The quantities given above intended for altitudes in the 14,0 to 15,000-foot range. To transl backward for lower altitudes, add teaspoon baking soda per 1,000-f descent. Also, add ½ tablespo sugar and ½ teaspoon shortening each 1,000-foot drop and subtrac tablespoon of milk for every 2,5 feet. Reduce oven temperature 4° 1,000 feet of descent.

Rocky Mountain Icing

1 cup sugar
¼ cup water
¼ cup light corn syrup
1 egg white
2 marshmallows, cut in eighths
½ teaspoon vanilla extract
¼ teaspoon almond extract

1. Stir together sugar, water, a corn syrup in a saucepan.
2. Bring to a boil and continue cook over high heat until ici reaches the soft-ball stage (202 14,000 feet. For lower elevatio add 2° for each descent of 1,0 feet. For example, at sea level, t soft-ball stage is reached beg ning at 234°; at 7,500 feet abo sea level, the equivalent tempe ture is 219°).
3. Beat egg white until stiff. Scat marshmallow bits over it. The pour on the hot syrup and beat v orously until the icing holds shape and has almost complet cooled.
4. Beat in vanilla and almond e tracts and apply icing to cake.

Raymond Sokolov's most rec cookbook is The Saucier's Appre tice, *a guide to French sauces.*

THE AMERICAN MUSEUM OF NATURAL HISTORY ANNOUNCES EVENING LECTURE SERIES FOR ADULTS STARTING FEBRUARY, 1977

THE GRAND DELUSION—*6 Tuesdays starting February 8, 7:30-9:00 p.m. Fee: $25.*
Human curiosity has discovered the Americas, photographed Mars, isolated antibiotics and concocted mayonnaise. However, a mocking and attractive delusion walks beside each scientific field of knowledge. In this illustrated series, four noted scholars in the history of ideas explore six of the grandest and most persistent human delusions that still haunt 20th century science—Atlantis, Astrology, Dream nterpretation, Underworlds, Alchemy and Decipherment. Professors Claireve Grandjouan, Jean R. Bram, Robert J. White and Tamara M. Green, all from Hunter College, The City University of New York.

UNDERWATER ARCHAEOLOGY IN THE MEDITERRANEAN: Ancient Ports, Ships and Travelers—*6 Wednesdays starting February 23, 7:30-9:00 p.m. Fee: $25.*
Dr. Anna Marguerite McCann, one of the major archaeologists working under the sea in the Mediterranean, will explore the importance of ancient harbors, concentrating on recent underwater excavation which she has directed. The historical setting, the significance of the sites and the artifacts found will be included with a background on the rade and travelers of the times.

AN ANTHROPOLOGIST AND A VILLAGE—*6 Wednesdays starting February 9, 7:00-8:30 p.m. Fee: $25.*
Drawing on a fine collection of colored slides, Dr. Malcolm Arth, Curator at the Museum, shares his experiences in a West African village and in a Native American community as a basis for discussing the many facets of living with other peoples; and recreates the frustrations and joys of the cultural anthropologist engaged in field work.

AN AWAKENING IN ANTHROPOLOGY—*7 Thursdays starting February 10, 7:00-8:30 p.m. Fee: $30.*
Social "trivia," from naming dogs to patterns in swearing, even the choice of paints for a home are now considered significant social data with complex symbolic meanings. Paul J. Sanfacon, Lecturer in Anthropology at the Museum, brings to light some present-day thinking of anthropologists about both modern and tribal societies.

EXPLORE WEAVING—*10 Tuesdays starting February 8, 7:00-8:30 p.m. Fee: $60.* **Limited Enrollment.**
In this introductory workshop, Kate Bennett-Mendez of the Museum's staff will explore the evolution and history of weaving from an anthropological point of view. Lecture/demonstrations focus on techniques, materials and looms used by North American Indian, Guatemalan, Peruvian, West African and Pacific Island weavers.

MEDICAL ENTOMOLOGY—*8 Thursdays starting February 10, 7:00-8:30 p.m. Fee: $30.*
Some insects look quite harmless but have helped to wipe out entire populations in some parts of the world and are a constant threat almost anywhere. In these slide-illustrated lectures, Dr. Mohammad Shadab of the Museum's Department of Entomology describes the insect vectors, their biology and the life cycles of the parasites they carry.

MUSHROOMS, MOSSES, FERNS AND OTHER NON-FLOWERING PLANTS—*5 Thursdays starting February 10, 7:00-8:30 p.m. Fee: $20.*
The non-flowering plants range from microscopic bacteria to gigantic kelps and conifers. In this series of slide-illustrated talks, Helmut Schiller, Lecturer in Botany at the Museum, introduces diverse plants: mushrooms, mosses and ferns of forest floors and meadows; lichens of rocky and sandy places; algae at the edge of the sea; and conifers.

THE WORLD OF MAMMALS—*8 Wednesdays starting February 9, 7:00-8:30 p.m. Fee: $30.*
A survey of some of the world's more interesting and unusual mammals. In addition to slide-illustrated lectures, visits will be made to three of the Museum's exhibition halls, where a variety of North American mammals will be seen in their natural habitats. Kenneth A. Chambers is Lecturer in Zoology at the Museum.

Special Tour of the new SECTION OF METEORITES, MINERALS AND GEMS—*2 Tuesdays, Feb. 22 and March 1; and repeated 2 Thursdays, March 31 and April 7; 7:00-8:30 p.m. Fee: $10. (Indicate preferred dates.)* **Limited enrollment.**
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Celestial Events

by Thomas D. Nicholson

Sun and Moon The sun is in the constellation Sagittarius in early January, moves into Capricornus about January 19, and into Aquarius about mid-February. Its motion through Sagittarius, almost parallel to the equator, keeps it well south and low in our sky, bringing short days. But in Capricornus it moves rapidly north, almost halving its distance from the equator before leaving that constellation. Sunset occurs perceptibly later by the end of January, although sunrise has not advanced much since winter began.

The morning moon of the second and third week of January (last-quarter on the 12th) becomes new on January 19 and should show up as an evening object (near Venus) by the 22nd. First-quarter is on January 26, full moon on February 3, and last-quarter again on February 10. After being a bright evening object in late January and early February, the moon returns to the morning sky.

Stars and Planets Evening skies this month and in February bring Venus and Jupiter into greater prominence as evening stars, although Venus sets too early to appear on our evening Star Map. You should find it without trouble, however, quite brilliant in the southwest from dusk until it sets after dark. Jupiter is on the map in Aries, near the border with Taurus, where it appears well up in the east in the early evening, setting before dawn. Saturn is on the evening map, too, although it is a morning star until February 2. It rises shortly after dusk, in Cancer, moves up into the south past midnight, and still shines in the west at dawn. Mercury and Mars are too close to the sun for easy viewing. Among the telescopic planets, Uranus is in Libra, Neptune in Ophiuchus, and Pluto in Virgo; all are morning stars.

January 3: Earth is at perihelion, nearest the sun.

January 4: Latest sunrise of the year.

January 5: Mercury, in inferior conjunction, becomes a morning star.

January 15: Jupiter resumes its direct (eastward) motion through the stars. Watch it move toward the Pleiades and the Hyades (in Taurus) over the next several weeks.

January 16: Moon at perigee, nearest earth.

January 17: Mercury ends its retrograde motion.

January 22–23: The moon is near Venus, moving from right to left above the planet, nearest (conjunction) at 6:00 A.M., EST, on the 23rd.

January 24: Venus is at greatest eastern elongation, most favorably placed for viewing to the left of the sun in the evening sky.

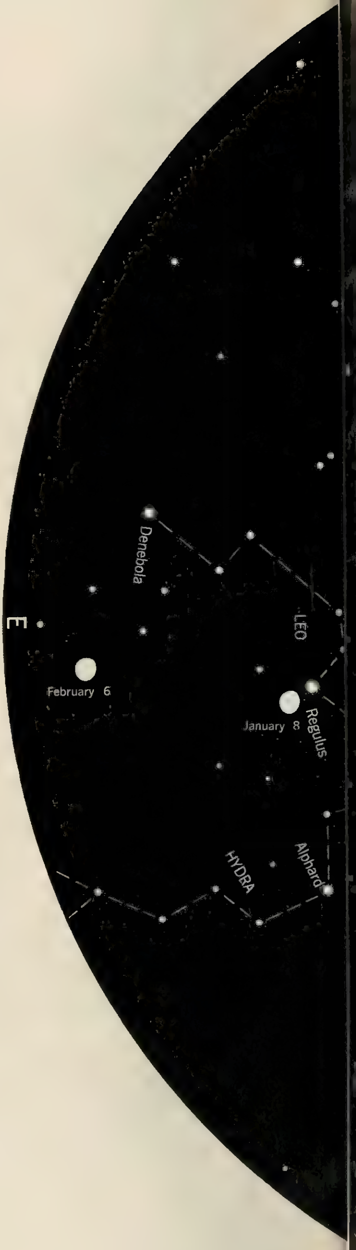
January 27–28: The moon, moving from right to left below Jupiter, is close to the planet on both evenings. On the 28th, moon is at apogee, farthest from earth, and Mercury is at greatest elongation in the morning sky, but not well placed for viewing.

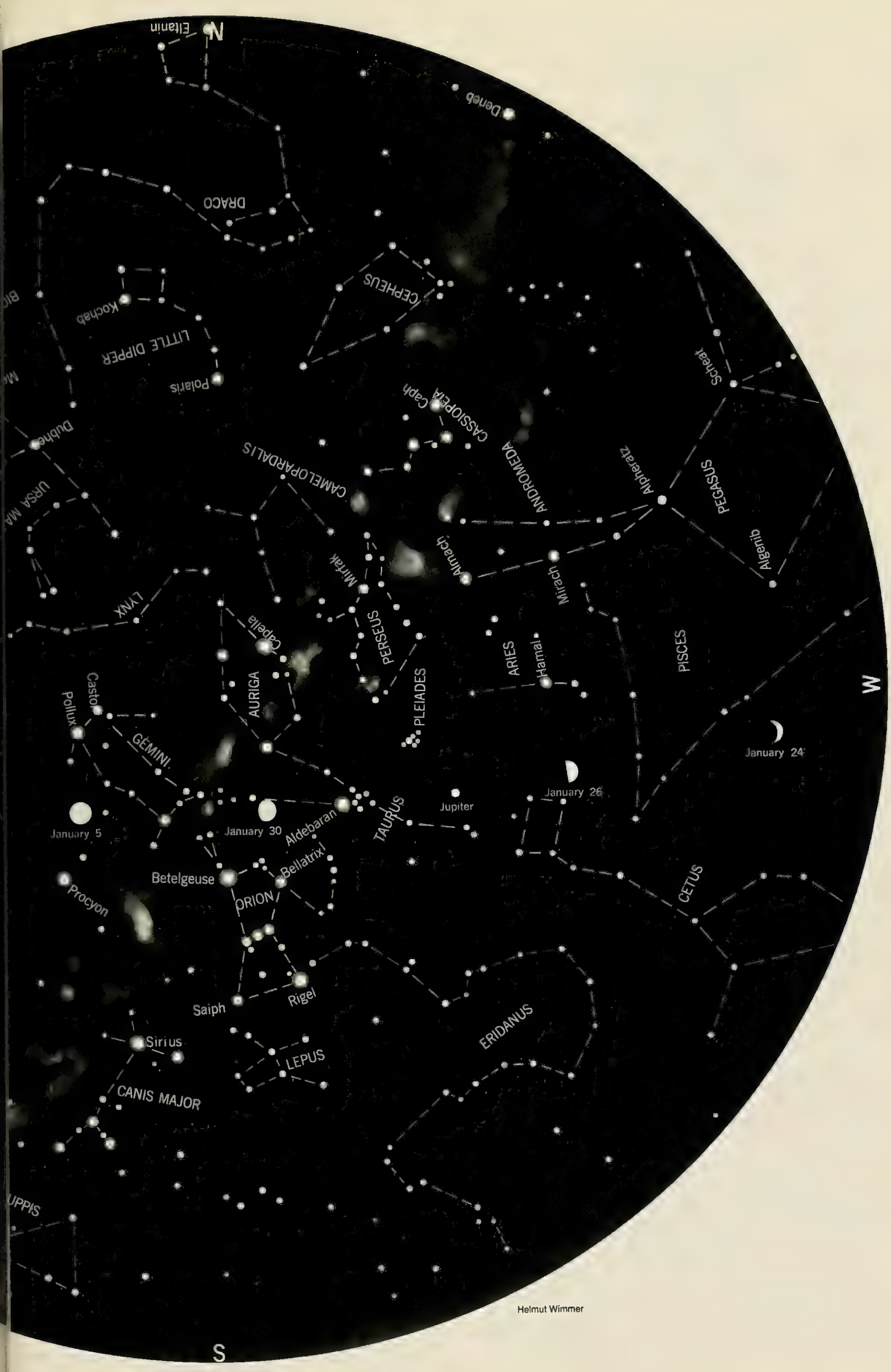
February 2–3: Saturn is at opposition from the sun, rising at sundown, setting at sunrise. It now becomes an evening star. On the night of February 3, the full moon passes close by below the planet.

February 10: The moon covers Uranus (an occultation) over parts of Europe and Africa. The moon is at perigee late in the day.

February 12: Mercury and Mars are in conjunction and quite close to one another, but too poorly placed to be seen.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:15 P.M. on January 15; 9:15 P.M. on January 31; 8:15 P.M. on February 15; and 7:25 P.M. on February 28; but it can be used for an hour before and after those times.

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any astrophysicists

''The greatest crisis in physics of time,'' is the way physicist John heeler of Princeton University de-ibed the entrance of black holes o respectable quarters in the scien-c community. Defying all sense d reason, the black hole is an addi-nal bit of mischief created by the ory of relativity in its continued slaught on the bastions of intuitive rception and everyday experience.

The story of black holes begins in-cuously in the swirling clouds of drogen that surge and eddy oughout all space. Stars are born these clouds when, under their ran-m motions, numbers of atoms oc-sionally meet by accident to form all pockets of gas. Once formed, ocket of gas is held in the grip of own gravity. As time passes, the oms in the pocket ''fall'' toward its nter, picking up speed as they fall. ey meet at the center and pile up a dense mass, the temperature ounts, and when it reaches roughly enty million degrees Fahrenheit, clear reactions flare up and a star born.

The star lives out its life in the bal-ce between the outward pressure nerated by the continued release of clear energy at its center and the ward pressure created by the pull of gravity. When a star's reserves of clear fuel are exhausted, the bal-ce is destroyed and the star col-pses under its own weight. If the ar is modest in size, like our sun, e collapse is relatively gentle and e star fades out slowly in the linger-g death of a white dwarf. When the star is massive, it does not fade away; instead it collapses rapidly and violently, and rebounds from the collapse in a cataclysmic explosion known as a supernova. A glowing cloud of debris expands from the site of the explosion at a speed of thousands of miles per second. Buried in the cloud is the compressed remnant of the star's core—either a neutron star or a black hole in space.

A neutron star is a lump of matter with a mass comparable to that of the sun, but squeezed so severely that the separate electrons and electron nuclei within it have combined to form neutrons—subatomic particles having no charge. This ball of pure neutrons, about ten miles in radius, is so dense that a matchbox filled with matter from it would weigh several billion tons. The ball of neutrons, spinning rapidly on its axis several times a second, emits flashes of radiation that move through space like the light from a rotating lighthouse beacon. These flashes periodically sweep across the earth and are observed by astronomers here as regularly repeated pulses of radiation. They are responsible for the neutron star's other name—the pulsar.

Neutron stars, or pulsars, are relatively well-understood objects. Their general properties can be explained without difficulty, and their existence creates no strains in the body of science. Black holes are another matter. According to experts in relativity theory, their existence is certain; it is an inexorable consequence of the laws of relativity, combined with all known facts on the birth and death of stars. When a star's nuclear fuel is burned up, the star *must* collapse under the force of its own weight. If the star is fairly massive, its core will be squeezed down to a radius of approximately ten miles and a ball of pure neutrons will form there; if it is extremely massive, the force of the collapse will squeeze the core down to an even smaller radius. If the core is squeezed down to a radius of about two miles, the theory of relativity predicts the sudden occurrence of an extraordinary phenomenon.

According to Einstein's theory, a ray of light should possess mass. If Einstein is right, a ray of light emitted from a star will be pulled back by the star's gravity, as a ball thrown up from the surface of the earth is pulled back by the earth's gravity. When a star is normal in size—about one million miles in diameter—the force of gravity on its surface is not strong enough to keep the light rays from escaping and they leave the star, although with their energy somewhat diminished.

But if the matter of the star is squeezed into a very small volume, the force of gravity on its surface is very great. This can happen to the core of a star as a result of a supernova explosion. Suppose the core—which may be several times as massive as the sun—is squeezed down to a radius of a few miles. At that point, the force of gravity at the surface of this compact mass is billions of times stronger than the force of gravity at the surface of the sun. The tug of that enormous force prevents any rays of light from leaving the surface of the star; like the ball thrown upward from the earth, they are pulled back and cannot escape to space. All the light within the star is then trapped by gravity; no radiation can emerge. From that moment on, the star is invisible. It is a black hole in space.

If the mass of a star is exceptionally great—for example, twenty or thirty times the mass of the sun—calculations indicate that the entire star, and not merely the core, will become a

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black hole when the star collapses the end of its life.

The force of gravity within a bla hole not only prevents light fr escaping; it also prevents all physi objects from getting out of the ho This property of black holes is a other prediction of Einstein's theor which asserts that no object can trav faster than light. If the black hole gravity is so powerful that light ca not break its grip and escape to spac material objects cannot escape eithe Everything inside the black hole trapped there forever.

Any ray of light or physical obje that enters the black hole from th outside can never emerge again. Th interior of the black hole is con pletely isolated from the outsid world; it can take in objects and radi tion but cannot send anything back

Once a black hole forms, gravit continues to draw everything inside toward the center. According to cu rent knowledge in theoretical phy ics, the atoms of the star pile up the center in a dense lump that contracts steadily. First the materials the star shrink to the size of a pinhead then to the size of a microbe; an then, still shrinking, they pass int the realm of distances smaller tha any ever probed by man. All th while, a mass of ten thousand trillio trillion tons remains packed into th contracting volume.

But while the materials of the sta shrink to microscopic size at the center, the radius of the black hole remains unchanged because no mas has disappeared. It is all still there at the center of the hole, exerting th same powerful force of gravity on objects and rays of light in its neighborhood.

In fact, since black holes capture any material they encounter, the mass and therefore the radius of a black hole will always tend to increase in time. A black hole is, in a sense, insatiable. As more matter enters it, its gravitational pull increases, and therefore its boundary expands.

This property does not imply that black holes act as gravitational vacuum cleaners, drawing in matter from the space around them. A ray of light, a star, or a spaceship can pass by a black hole safely as long as it does no come too close. However, if the object is on a collision course with a black hole, it will enter the hole and vanish. Even if its course carries it within a mile or two of the hole's boundary, the gravitational pull of the k hole will curve the path of the ct so that it enters and disappears. 'hat would happen to an astroicist who entered a black hole? vould be ripped apart because the of his body closest to the center e black hole would be pulled by onger gravitational force than any r part. Suppose, for example, an ophysicist entered a hole feet his feet would be pulled more ngly than his head, and feet and l would tend to separate. The ashysicist would feel as though he e being stretched on a rack; a few sandths of a second after entering lack hole, he would be dismemd; after a few more thousandths second, the individual atoms of ody would be broken into their rate neutrons, protons, and elecs; finally, the elementary pars themselves would be torn into ments whose nature is not yet wn to physicists.

ntuition tells us that an object as rre as a black hole cannot exist, he relativists insist that they must resent in the universe in great bers. It seems impossible to h the relativists out in the matter, e the black hole, by its nature, is bservable. However, recent res in X-ray astronomy provide inct evidence that at least one black e actually does exist. X-ray obserons of the heavens made by kets and satellites show a powerful rce of X-rays, with unusual perties, in the constellation gnus. The source, named Cygnus , is in the vicinity of a blue supernt—a massive, very bright, blueored star. The spectrum of the blue ergiant indicates that it is a memof a binary, that is, a pair of close s waltzing round one another er the pull of their mutual gravital attraction. Apparently, the inble source of the X-rays is the r member of the binary.

his pair of stars seems to provide evidence for the existence of k holes that theorists have been king. When the stars in a binary relatively close together, the pull each star's gravity draws matter y from its companion and streams gas flow back and forth between two stars. If one star becomes a k hole, the gas drawn out of the er star will continue to stream ard its companion; but as this gas roaches the boundary of the black e, it will be accelerated to exnely high velocities by the black

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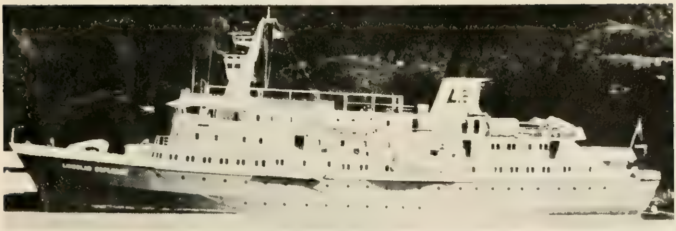

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hole's gravitational force. The
idly moving particles, convergin
the black hole, will collide with
another and produce an inte
stream of X-rays, making the b
hole an X-ray source of the kind
served by the X-ray satellites.

Furthermore, as the two stars
volve around one another, the X-
emanating from the vicinity of
black hole will be periodic
blocked by its companion. Cyg
X-1 fits this description precisely,
cause the intensity of the X-rays c
ing from it vary regularly every
days.

What about other explanations
Cygnus X-1? According to
theory, the invisible member of
binary could be a neutron star inst
of a black hole, since neutron s
also emit X-rays. However, this
turned out to be unlikely. The prop
ties of the binary in which Cyg
X-1 is located indicate that its e
mated mass is at least six times
mass of the sun. But calculati
show that the mass of a neutron s
cannot be greater than two or th
solar masses. Thus the neutron s
explanation seems to be excluded.
black hole is consequently the m
acceptable explanation remainin
There is a general reluctance to acce
the existence of black holes becau
they are such peculiar objects, b
Cygnus X-1 appears difficult to int
pret in any other way.

Black holes remind physicists
the time at the beginning of this ce
tury when, although physics seem
triumphant, the laws of the ato
prophesied the imminent collapse
the universe. There was no way th
to make sense out of the atom, ju
as there is no way today to make sen
out of the black hole. The revol
tionary concepts of quantum m
chanics saved the universe from ann
hilation in that earlier crisis, at th
tremendous cost of removing fund
mental physics forever from the d
main of ordinary experience. Revol
tions are exciting but painful, and a
aura of discomfort pervades the sc
entific community today as it awai
the next revolution in physic
thought, which, we now suspec
cannot be too many years off.

An astrophysicist, Robert Jastrow
the founder and director of the God
dard Institute for Space Studies i
New York City. He also teaches geo
ogy and astronomy at Columbia Uni
versity and Dartmouth College.

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The superb itinerary, planned in consultation with Museum scholars and scientists, overlooks no opportunity to reveal and illuminate, to veer off the traveled paths for special, extra insights.

The expert arrangements will be supervised by W.F. and R.K. Swan, Ltd. of London. Every detail has been scrutinized to contribute to your comfort. We'll use only the best accommodations on a spacious, gracious ship (70% of the cabins, but 100% of the crew and service staff). We've booked rooms at the two best hotels in Venice for the two nights before m.t.s. *Orpheus* becomes your home.

The company you'll keep includes a group of distinguished lecturers who will lead discussions, travel with you, share their own enthusiasms. There are six in all, including the American Museum's director, Dr. Thomas D. Nicholson. Two Museum ornithologists will concentrate on the bird life (they plan to take you to Scutari in Turkey, the best of all possible places to watch the spectacular Fall migration of thousands of birds). An Oxford don, a Brown University archeologist, the former director of the British Museum will share the honors when you're visiting archeological digs or admiring works of art.

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Books in Review

by Gerald Carson

Wildlife Recaptured

THE WORLDS OF ERNEST THOMPSON SETON, edited by John G. Samson. *Alfred A. Knopf, Inc., $25.00; 204 pp., illus.*

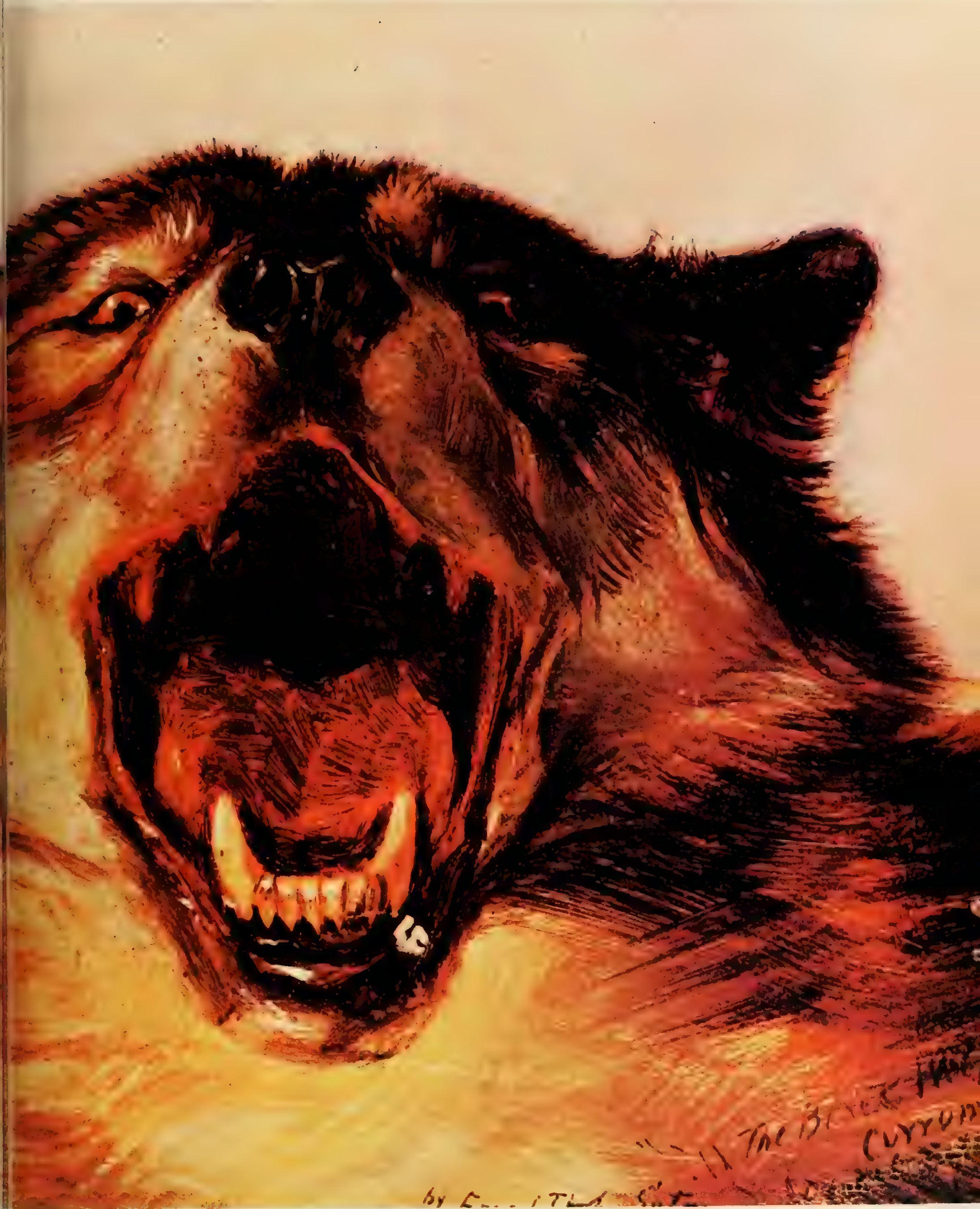
Ernest Thompson Seton was born at the right time and with the right talents to become celebrated as a sympathetic and popular interpreter of the back to nature sentiment that flourished about the turn of the century. The frontier was officially closed. A predominantly urban and suburban America was shaping up. Seton was a transitional figure of extraordinary versatility—a recognized field naturalist, a copious writer of wide influence, a frequent lecturer on wildlife, and an animal artist who knew, as Mr. Samson says in his introduction to the present volume, "where each muscle, bone, and tendon belonged."

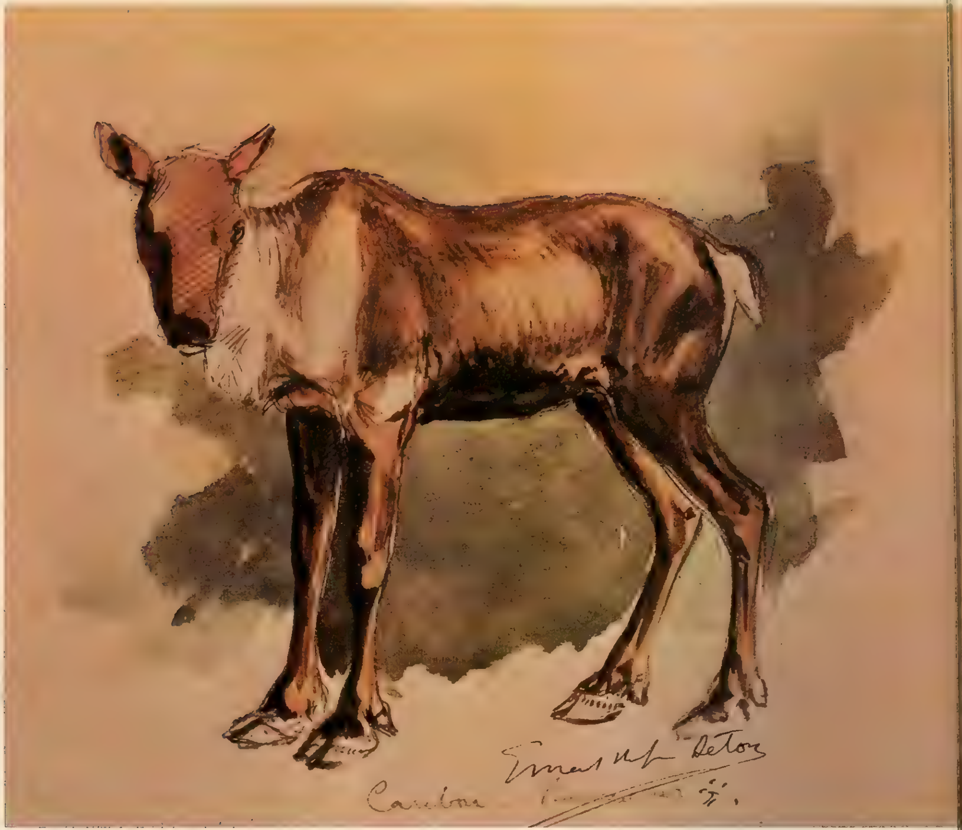
If Seton's art has occasionally seemed to be ancillary to his immensely popular writings, the balance is handsomely redressed in the present collection, which reproduces—in 10¼- by 11½-inch pages—a careful selection of the outdoorsman's full-color paintings and a generous gathering-up of the quick studies, done in pencil, ink, or watercolor, that appeared as data in his field notebooks and were later worked up as illustrations for his books and articles.

Mr. Samson, the compiler, who is also editor of *Field and Stream* magazine, divides his book into discrete sections devoted to the fauna of the far north, the east, and the west, with a closing section on Indians and woodcraft, and a selective bibliography of Seton's books. Biographical material and commentary by the editor introduce each of the sections, followed by brief excerpts from several of Seton's forty-odd books, among them *Trail of an Artist-Naturalist* (1940), *Lives of Game Animals* (1925–27), *Life Histories of Northern Animals* (1909), *Arctic Prairies* (1911), *Wild Animals I Have Known* (1898), *Lives of the Hunted* (1901), and *Animal Heroes* (1905).

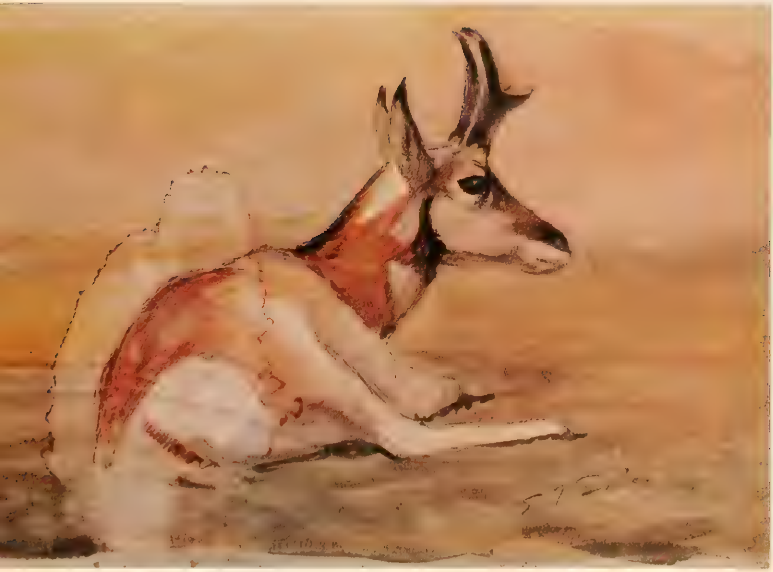
Originally named Ernest Seton Thompson, the artist-naturalist was born in England in 1860 and grew up in the wilds of Canada. He came early to his vocation, building a woodsy shack of his own when he was fourteen years old. Later he studied at the Royal Academy of Art in London and under French artists, sketching from life in the menagerie of the Jardin des Plantes in Paris where, a generation later, the *grand animalier,* François Pompon, found the models for his renowned sculptures of the stag and polar bear. Something of a prodigy, Seton was first published when he was barely in his twenties. In 1883, while still living in Canada, he changed his name legally from

Lobo the wolf





Caribou calf



Pronghorn antelope

Thompson to Seton, a change confirmed in the Supreme Court of New York in 1901 because many of his copyrights had been taken out in the name "Seton-Thompson."

Apart from lecture tours and periodical visits to the wilderness to refresh his vision, Seton spent his most productive years in New York and vicinity. There he wrote and illustrated his books and received a flow of commissions to illustrate the works of other authors: one editor, for example, ordered a thousand drawings. Friendships developed with curators and department heads of The American Museum of Natural History, with scientists at the U.S. Biological Survey and the New York Zoological Park, and with a highly visible personality concerned with the preservation of America's native fauna, the president of the United States, Theodore Roosevelt.

Along with honors, awards, and prosperity, came sharp controversies.

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1. The competition is open to everyone except employees of The American Museum of Natural History and their kin.

2. Competitors may submit up to three previously unpublished entries in each of the four categories. Decision of the judges is final.

3. The Museum acquires the right to publish, exhibit, and use for promotion the winning photographs. The Museum assumes no responsibility for other entries.

4. Entries may be transparencies or prints up to 8 by 10 inches, and each must bear the photographer's name and address.

5. Enclose a self-addressed, stamped envelope for the return of entries.

6. Entries must be postmarked no later than April 15, 1977.

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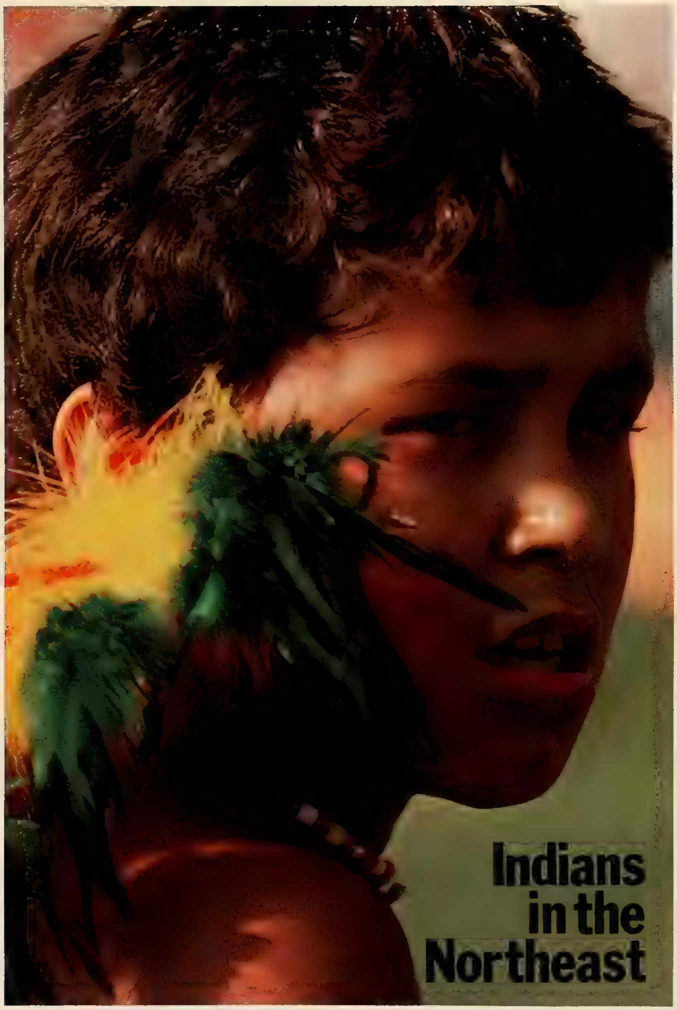
And, the best of luck!



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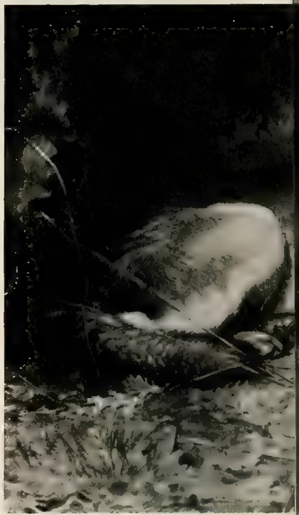
Seton's interest in young people
to his organization of the Woodc
Indians. Subsequently an abra
dispute arose among Lord Bad
Powell, the hero of Mafeking; Da
Carter Beard, like Seton a na
writer and illustrator; and Seton c
the proper distribution of credit
the founding and shaping of the in
national Boy Scout movement. T
disagreements ruptured old frie
ships and left a residue of alienati

A romantic in temperament, Se
was able as an artist to discipline h
self to observe the natural world ac
rately and catch the essence of e
creature in his sketchbooks—
timber wolf, the varying hare,
various members of the hawk fam
the caribou, badger, lynx, or wh
ever. He once counted the feathers
a Brewer's grackle. The total: 4,9
But when he wrote for a general au
ence, especially young people, Se
was unabashedly anthropomorph
giving his subject animals individ
names and personalities, such
Lobo the wolf, Johnny Bear,
Redruff the grouse. Criticism f
lowed from the scientific commun
John Burroughs, for instance, ch
tised Seton for introducing hum
motivation into what purported to
true accounts of animal behavior
insisted that Seton's widely read *W*
Animals I Have Known should m
properly have been entitled *Wild A*
mals I Alone Have Known. And Pr
ident Roosevelt, generally a frien
critic, while praising the autho



"The Sleeping Wolf"

teresting observations of fact,''
ommended that he be more cir-
nspect about introducing his vast
lience of juveniles to animals that
ld think symbolically, transmit a
ture, and perform acts of heroic
rifice reflecting human moral val-
. Some years later, after the publi-
ion of his four-volume monograph
American game animals, Seton re-
ved the John Burroughs Medal for
contributions to natural history.

Perhaps the greatest impact of *The
rlds of Ernest Thompson Seton*
n today's animal appreciator, liv-
in the culture of the 1970s with
urban sprawl and shrinking habi-
comes from a fresh awareness of
abundance of wilderness species
ilable for field study during
on's productive years. The eco-
tem was still relatively stable, al-
ugh Seton lived to see the extinc-
of the passenger pigeon and the
l of the wild buffalo herds. One
nders how this gifted man, essen-
ly a poet as well as artist, would
l if he could know that the 1976
ristmas catalog of Nieman-
rcus, the Texas department store
in, offered—as a gift to the couple
o had everything—his and her
y bison. Price, complete with
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men's attitudes toward animals
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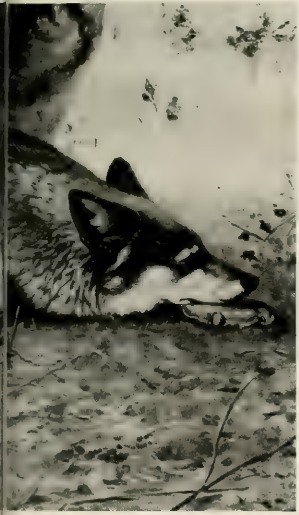

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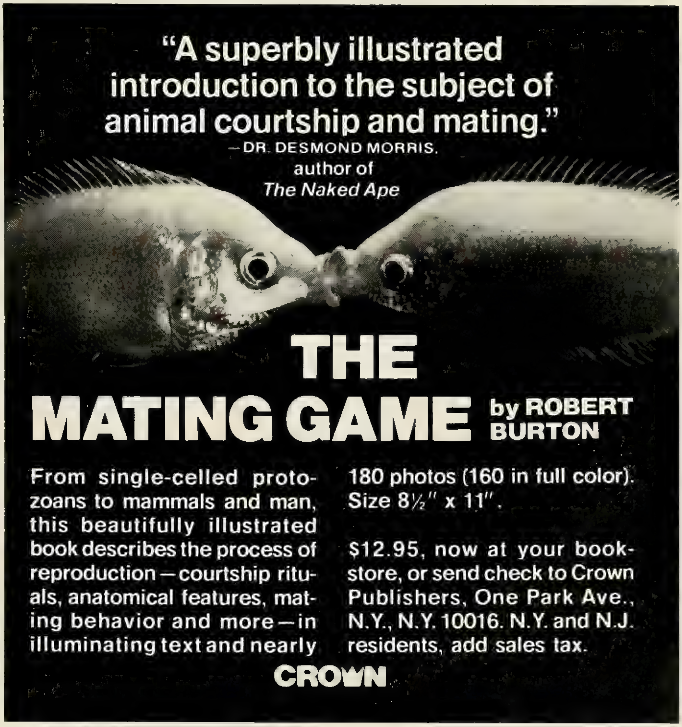
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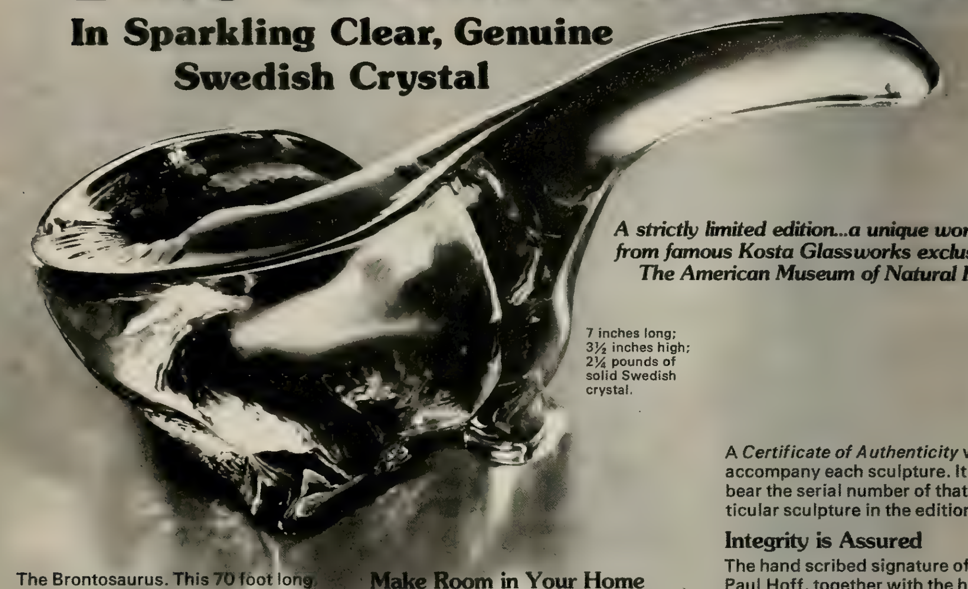

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Connoiseurs of crystal collectibles will readily acknowledge the reputation of Kosta among the world's great crystal makers. Their name assures the quality of the full-lead crystal and the excellence of the hand craftsmanship.

The Sculptor: Paul Hoff

The Brontosaurus sculpture was created by Paul Hoff whose works are represented in museums and galleries on three continents. He has combined scientific evidence with the artist's prerogatives to form pure crystal into a sculpture of fascinating beauty.

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ckyard Beauty

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ting on a telephone pole. So, upon
ning home this evening and find-
; an article about the bird in your
vember issue, I discovered some-
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Having observed these birds for

re on the last two pages
lendar, entitled Powwow in New
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LOUISE MAGAW ACKERMAN
Lincoln, Nebraska

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LAURA B. SINDLINGER
Elmira, New York

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I think if any of the Indian veterans of the Forty-fifth Division, to which I had the honor of being attached for a time in Italy in 1943–44,
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he Western Indians do.
Narragansets, the Pen-
Mohawks, the residual
ons, and the few Shinne-
our calendar.

PAUL VAN GIESON
Hillsdale, New Jersey

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flag was selected for the
ecause it strongly revealed
nt of American Indian life
fact that this act is con-
major public gathering of
d others is a revealing com-
ut our society today. This
mean that we approve of
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A Correction

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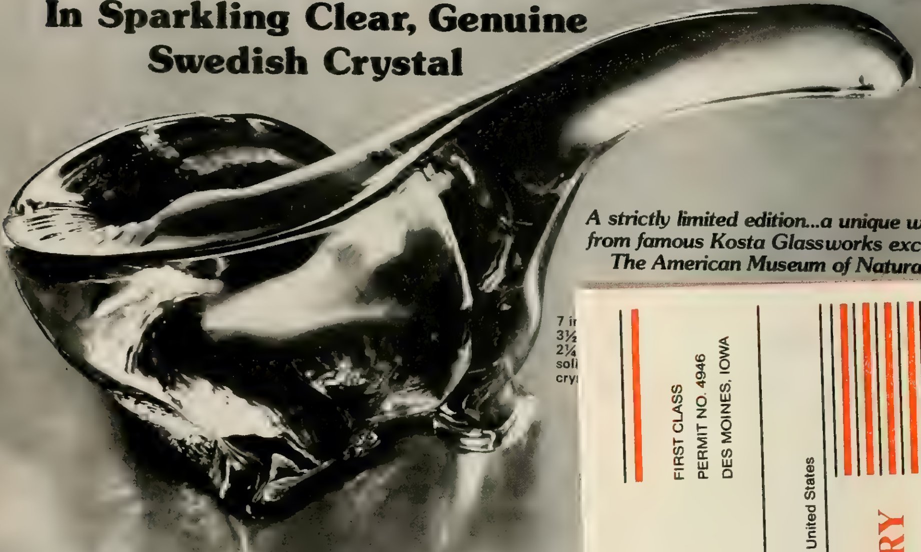

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On my way to work this morning noticed a large white-tailed kite sting on a telephone pole. So, upon ming home this evening and findg an article about the bird in your ovember issue, I discovered someing truly relevant to my daily exence. A day seldom passes that I il to see these magnificent birds.

Having observed these birds for veral years since moving to southn California, I was thrilled to read out their unique beauty and huntg skills.

One does not need to travel the orld over to find a “rare” creature great beauty. Thank you for pubhing Lee Waian's article on a bird any people fail to notice in the area here I live.

JANET ROYSTER
Irvine, California

he Turbulent Sun

I've just finished looking at your ovember issue. The sun has never emed so near. I appreciate your oughtful arrangement of articles d photos.

MICHAEL ROBINSON
Battle Ground, Washington

he Turbulent Calendar

In your 1977 calendar, which feares pictures of Indians in the Northast, some of the pictures are of terest and are historical. Some are ven beautiful. However, the picre on the last two pages of the alendar, entitled Powwow in New ork, made me angry. The flag code f the United States definitely proibits displaying a flag as this Indian doing.

LOUISE MAGAW ACKERMAN
Lincoln, Nebraska

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I think if any of the Indian veterans of the Forty-fifth Division, to which I had the honor of being attached for a time in Italy in 1943–44, saw this display of contempt for the country, they would waste few words and take very little time in correcting this contemptible gesture.

I am disappointed by your poor judgement in selecting that photograph to represent the Northeast Indians. They have dignity and tradition, as the Western Indians do. Look to the Narragansets, the Penobscots, the Mohawks, the residual Seven Nations, and the few Shinnecocks for your calendar.

PAUL VAN GIESON
Hillsdale, New Jersey

EDITOR'S NOTE:

The photograph of the Indian wearing a flag was selected for the calendar because it strongly revealed one element of American Indian life today. The fact that this act is condoned at a major public gathering of Indians and others is a revealing comment about our society today. This does not mean that we approve of the action in the picture nor that we meant to defile the flag.

We are fully aware that, as editors, we are particularly fortunate to be working in the country of that flag, where the freedom of the press to publish both good and bad information is a fundamental right.

A Correction

In Edward Abbey's book review (November 1976), his assumption that an orchid is a parasite is simply wrong. In this largest family of the plant kingdom, the nonterrestrial members are epiphytes. Although several nongreen species have symbiotic relationships with fungi, no orchids are parasitic.

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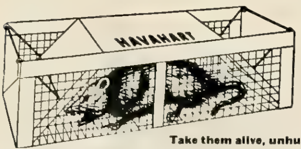

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Announcements

The American Museum-Hayden Planetarium is now offering a **Saturday Morning Sky Show for Children** at 11:00 A.M. A planetarium lecturer will explain why the moon changes shape, why the seasons change, what shooting stars are, and how the nighttime sky would look without the city's lights and pollution. The lecturer will also discuss the status of such current space research as the *Viking* Project to Mars, *Pioneer*'s journey to Jupiter and Saturn, and *Mariner*'s flight to Venus and Mercury. The show is designed for children in grades six through eight. Special rates are available for groups of ten or more. For further information call 873-1300, extension 206.

A small exhibit of nineteenth-century **Mongolian Jewelry and Ornaments** will open in the Museum's Roosevelt Rotunda on January 20 and run through March 1. The display includes women's necklaces, rings, earrings, and headbands, as well as various ornaments used by men. All handcrafted, the pieces are made from locally mined silver, inlaid with coral, torquoise, and jade. One of the attractions of Mongolian silversmithing of the last century is the contrast between the delicately crafted silver and the usually rough-hewn inset minerals.

Places are still available on the Museum's **Anthropology Tour to Morocco,** April 2 to April 16, 1977. The trip is especially designed for persons interested in discovering the diversity of Moroccan culture. Led by Paul J. Sanfacon, Museum lecturer in anthropology, participants will visit mosques and the king's palace in Rabat and the medieval Muslim city of Fes. The tour will continue through the Atlas Mountains to Rissani, crossroads of the caravan trade between the Sudan and North Africa, and will include the city of Marrakech. Throughout the journey, visits will be made to archeological sites, museums, ancient towns, and markets. For further information call 873-1300, extension 341.

Note: The Museum's geology tour of Iceland and Greenland, scheduled for August 10 to August 30, 1977, has been cancelled.

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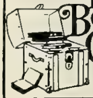

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canoes and Climate (p. 8)

red M. Bullard's *Volcanoes of the th* (rev. ed. Austin: University of as Press, 1976) and Gordon A. Mac- ald's *Volcanoes* (Englewood Cliffs: ntice-Hall, 1972) are well-illustrated oductions to volcanic phenomena and r effects on the environment and ple. *Krakatoa*, by Rupert Furneaux glewood Cliffs: Prentice-Hall, 1964), hically describes one such eruption the resultant destruction. Nigel der's *The Weather Machine* (New k: Viking Press, 1975, $14.95) and d A. Bryson's "A Perspective on Cli- ic Change" (*Science*, 1974, vol. 184, 753–60) provide general introduc- is to weather and climatic change. For re detailed discussions of climate rela- to volcanic explosions see these ks by H. H. Lamb—*Climate: Past, sent and Future* (London: Methuen, 2), *The Changing Climate* (New k: Barnes & Noble, 1972, $4.50), "Volcanic Dust in the Atmosphere, h a Chronology and Assessment of Its teorological Significance" (*Philo- hical Transactions of the Royal Soci- of London*, 1970, vol. 266, pp. –533). "Volcanic Explosions and matic Change: A Theoretical Assess- nt," by J. B. Pollack et al. (*Journal eophysical Research*, 1976, vol. 81, 1071–83), describes how volcanoes ct climate. J. B. Hoyt discusses the isual weather during the year 1816 and impact on society in "The Cold Sum- r of 1816" (*Annals of the Association American Geographers*, 1958, vol. pp. 118–31).

og Reproduction (p. 38)

Originally published in 1931, G. ngsley Noble's *The Biology of the Am- ibia*, nearly 600 pages and with 320 istrations, is still considered the defini- e reference work on this group; an in- pensive paperback edition is now avail- le (New York: Dover Publications, .50). David L. Jameson surveys repro- ction in the frog families in "Evolu- nary Trends in the Courtship and Mating Behavior of Salientia" (*Systematic Zoology*, 1955, vol. 4, pp. 105–19). B. Lutz's "Trends Towards Non-Aquatic and Direct Development in Frogs" (*Copeia*, 1947, vol. 4, pp. 242–52) and Coleman J. Goin's "Amphibians: Pioneers of Terrestrial Breeding Habits" (*Annual Report of the Smithsonian Institution*, 1959, pp. 427–45) deal with the modifications of the basic amphibian mode of reproduction. Grace L. Orton's "Some Aspects of Ecology and Ontogeny in the Fishes and Amphibians" (*American Naturalist*, 1955, vol. 89, pp. 193–203) and "The Bearing of Larval Evolution on Some Problems in Frog Classification" (*Systematic Zoology*, 1957, vol. 6, pp. 79–86) provided some of the evolutionary groundwork for theoretical statements such as Joseph A. Tihen's "Evolutionary Trends in Frogs" (*American Zoologist*, 1965, vol. 5, pp. 309–18). Recent studies of amphibians are reviewed in *Evolutionary Biology of the Anurans*, edited by James L. Vial (Columbia: University of Missouri Press, 1973); see, in particular, George B. Rabb's "Evolutionary Aspects of the Reproductive Behavior of Frogs" (pp. 213–27) and Stanley N. Salthe and William E. Duellman's "Quantitative Constraints Associated with Reproductive Mode in Anurans" (pp. 229–49).

American Hasidim (p. 46)

In *Legends of the Hasidim* (Chicago: University of Chicago Press, 1974, $5.95), Jerome R. Mintz describes the mores and history of present-day communities, analyzes the cultural content of more than 370 folk legends, and explores the intimate relationships between hasidic legend and law, rituals and values, roles and social structure. Sensitive photographs enhance this work. For sociological insights into the New York communities see Solomon Poll's *The Hasidic Community in Williamsburg: A Study in the Sociology of Religion* (New York: Schocken Books, 1969, $3.45) and Israel Rubin's *Satmar: An Island in the City* (New York: Quadrangle, 1972, $8.95). In *Major Trends in Jewish Mysticism*

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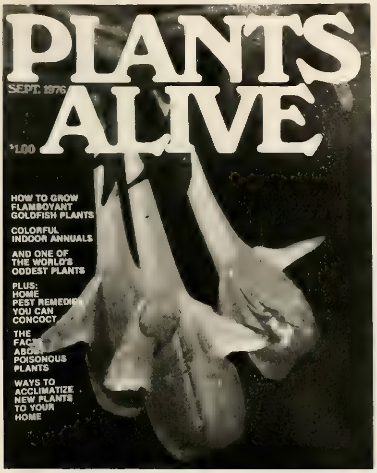
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(3rd ed. New York: Schocken Bo
$2.95), Gershom Scholem analyze
hasidic belief system, as does Alan
terman in *The Wisdom of the Jewish*
tics (New York: New Directions Pub
ing, 1976, $2.45). Originally publi
in Hebrew in 1814, *In Praise of the*
Shem Tov: The Earliest Collectio
Legends About the Founder of Hasid
translated and edited by Dan Ben-A
and Jerome R. Mintz (Bloomington
diana University Press, 1972, $3.
offers an introduction to the histo
roots of hasidism. The novels and st
of I. J. Singer and his brother Isaac
shevis Singer often provide moving
penetrating accounts of hasidic life in
land and America. *In My Father's Co*
I.B. Singer's autobiographic accoun
his childhood in a family of has
rabbis, is an outstanding example.

Mount Rushmore (p. 60)

Gilbert C. Fite's *Mount Rushm*
(Norman: University of Oklahoma Pr
1964, $2.95) explores many aspect
this monumental project—from fun
and engineering to the sociology of
project and of the time period its
struction encompassed. Although wr
for younger readers, Willadene Pri
Gutzon Borglum: Artist and Patriot (
cago: Rand McNally, 1961) is a caref
researched biography of the Mount R
more sculptor, providing a perspectiv
his other artistic endeavors, such as
carvings at Stone Mountain, Georgi
somewhat less objective account of B
lum's life, *Give the Man Room,* was
ten by Robert J. Casey and Mary B
lum (Indianapolis: Bobbs-Merrill, 19
Frederick G. Vosburgh's "Shrines
Each Patriot's Devotion" (*National G*
graphic, January 1949, pp. 51–82) il
trates scores of national historic shri
including Mount Rushmore. For rea
wishing to do their own historical
search on contemporary attitudes tow
some past project such as Rushmore,
New York Times Index gives referen
to news articles, and even parts of
ticles, that deal with specific subjects

Slow Mammals (p. 66)

Ernest P. Walker's *Mammals of*
World (3rd ed. Baltimore: Johns Hopk
University Press, 1975) gives general
formation on slow mammals. "Ascen
the Primates," R.D. Martin's interest
article on prosimians, including mos
the slow primates, appeared in *Natu*
History (March 1975, pp. 52–61). S
cific, detailed information on this prim
suborder is contained in the 983 page
Prosimian Biology, edited by R.D. M
tin et al. (Pittsburgh: University of Pi
burgh Press, 1974). George S. Ca
dale's *Bush Baby Book* (Lond
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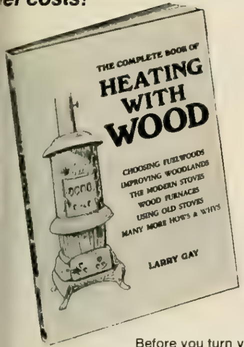

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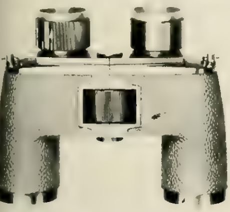

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For information on the bioenergetics of slow mammals see Terence J. Dawson's " 'Primitive' Mammals," in volume 3 of *Comparative Physiology of Thermoregulation*, edited by G. Causey Whittow, (New York: Academic Press, 1973, pp. 1–46). Dawson is also the author, with R. Degabriele, of one of the few studies of a slow marsupial: "The Cuscus, *Phalanger maculatus*—A Marsupial Sloth?" (*Journal of Comparative Physiology*, 1973, vol. 83, pp. 41–50). M. Goffart provides information on the physiology and anatomy of sloths in *Function and Form in the Sloth* (Elmsford: Pergamon Press, 1971). Goffart, an important contributor to our understanding of the biology of slow mammals, presents comparative data on a wide variety of these creatures in an article published jointly with G. Hildwein: "Standard Metabolism and Thermoregulation in a Prosimian *Perodicticus potto*" (*Comparative Biochemistry and Physiology*, 1975, vol. 50A, pp. 201–13). For pioneering scientific work on the vascular heat exchange structures in the limbs of slow mammals see "Countercurrent Heat Exchange and Vascular Bundles in Sloths," by P.F. Scholander et al. (*Journal of Applied Physiology*, 1957, vol. 10, pp. 403–11), and "Suggested Function of the Vascular Bundles in the Limbs of *Perodicticus potto*," by J.A. Suckling et al. (*Nature*, 1969, vol. 221, pp. 379–80).

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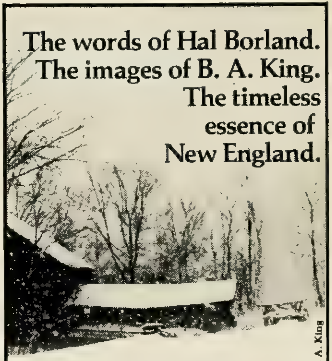

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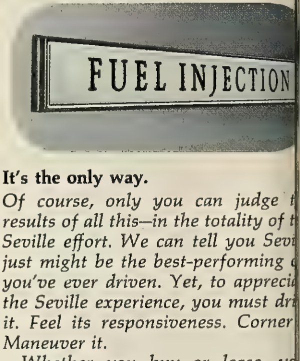

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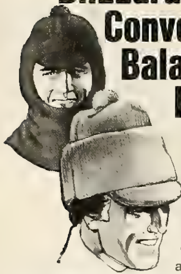

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As a teen-ager in rural Minnesota where he grew up, **Dean R. Snow** frequently examined the petroglyphs on a nearby rock outcropping. Even during those years, Snow knew that he wanted to be an archeologist. Since then he has conducted archeological research on American Indians from Mexico to Alaska to Maine and now teaches the subject at the State University of New York at Albany. Snow's article, "The Changing Prey of Maine's Early Hunters," appeared in the November 1974 issue of *Natural History* and his book, *The Archeology of North America*, was published last year. For the past three years, he has studied the archeology of New York's Lake George region; later this year, he will return to Mexico to continue the research he began more than ten years ago.

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After receiving her BA from the University of Toronto, **Dorothy Harley Eber** became a journalist. In 1968, a magazine assignment sent her to Baffin Island in the Canadian Arctic. There, in Cape Dorset, she met a highly articulate Eskimo woman artist, who, although not related to Peter Pitseolak, the subject of Eber's current article, had the same last name. Eber's admiration for this elderly woman's beautiful drawings led to the publication in 1972 of *Pitseolak: Pictures Out of My Life*. When the book came out, Peter Pitseolak remarked that there was certainly more to tell about Eskimo life and showed Eber the photographs he had taken over twenty years. Using interpreters and a tape recorder, Eber produced an oral biography in book form, *People from Our Side*, to accompany Peter Pitseolak's photographs. The article in this issue is adapted from that book.

Robert S. Desowitz began stu ing trypanosomiasis in 1951 at African Institute for Trypanosomi Research in Nigeria while on eighteen-month tour for the Bri government. "I became so captiv by Africa," he writes, "that I did emerge until nine years later. At time, my colleagues and I had g hope that the disease would be er cated or controlled. Today when meet, there is a consensus of des that little progress has been made that the situation may even have v sened." Desowitz now teaches tr cal medicine at the University Hawaii and is concentrating his search on malaria. His article, "H the Wise Men Brought Malari Africa," appeared in the Oct 1976 issue of *Natural History*.

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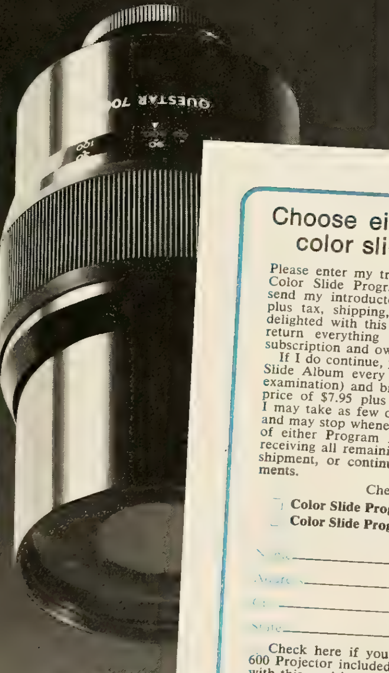

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For the past eleven years, **Bra Allan Branson** has explored the tent of damage to freshwater aq life of the southeastern United S due to highway and dam constru and strip mining (*see* "Stripping Appalachians," *Natural His* November 1974). A professor o ology at Eastern Kentucky Un sity, Branson is looking into th factory system of minnows, as as the distribution of terrestrial lusks on Washington's Olympic insula. He plans to expand thi search to include all such moll throughout the western United S and Canada. When not investiga freshwater fauna, Branson does w carving and writes poetry.

After receiving her BA from the University of Toronto, **Dorothy Harley Eber** became a journalist. In 1968, a magazine assignment sent her to Baffin Island in the Canadian Arctic. There, in Cape Dorset, she met a highly articulate Eskimo woman artist, who, although not related to Peter Pitseolak, the subject of Eber's current article, had the same last

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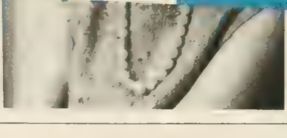

Hawaii and is

search on malaria. His article, "I the Wise Men Brought Malari Africa," appeared in the Oct 1976 issue of *Natural History*.

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This View of Life

by Stephen Jay G

The Continental Drift Aff

Scientists had a hard time solving this mystery, even though many clues pointed to the solution

As the new Darwinian orthodoxy swept through Europe, its most brilliant opponent, the aging embryologist Karl Ernst von Baer, remarked with bitter irony that every triumphant theory passes through three stages: first it is dismissed as untrue; then it is rejected as contrary to religion; finally, it is accepted as dogma and each scientist claims that he had long appreciated its truth.

I first met the theory of continental drift when it labored under the inquisition of stage two. Kenneth Caster, the only major American paleontologist who dared to support it openly, came to lecture at my alma mater, Antioch College. We were scarcely known as a bastion of entrenched conservatism, but most of us dismissed his thoughts as just this side of sane. (Since I am now in von Baer's third stage, I have the distinct memory that Caster sowed substantial seeds of doubt in my own mind.) A few years later, as a graduate student at Columbia University, I remember the a priori derision of my distinguished stratigraphy professor toward a visiting Australian drifter. He nearly orchestrated the chorus of Bronx cheers from a sycophantic crowd of loyal students. (Again, from my vantage point in the third stage, I recall this episode as amusing, but distasteful.) As a tribute to my professor, I must record that he experienced a rapid conversion just two years later and spent his remaining years joyously redoing his life's work.

Today, just ten years later, my own students would dismiss with even more derision anyone who denied the evident truth of continental drift—a prophetic madman is at least amusing; a superannuated fuddy-duddy is merely pitiful. Why has such a found change occurred in the s space of a decade?

Most scientists maintain—o least argue for public consumptic that their profession marches to truth by accumulating more and r data, under the guidance of an in ble, objective procedure called scientific method.'' If this were my question would have an eas swer. The facts, as known ten y ago, spoke against continental d since then, we have learned more revised our opinions accordingl will argue, however, that this nario is both generally inapplic and utterly inaccurate in this cas

During the period of nearly uni sal rejection, direct evidence for tinental drift—that is, the data g ered from rocks exposed on our co nents—was every bit as good as today. It was dismissed because one had devised a physical me nism that would permit continen plow through an apparently solid anic floor. In the absence of a pla ble mechanism, the idea of co nental drift was rejected as abs The data that seemed to suppo could always be explained away these explanations sounded contri or forced they were not half so probable as the alternative—acc ing continental drift. During the ten years, we have collected a new of data, this time from the oc basins. With these data, a heavy d of creative imagination, and a be understanding of the earth's inter we have fashioned a new theory planetary dynamics. Under t theory of plate tectonics, contine drift is an inescapable consequen The old data from continental roc once soundly rejected, have been humed and exalted as conclus proof of drift. In short, we now acc continental drift because it is the pectation of a new orthodoxy.

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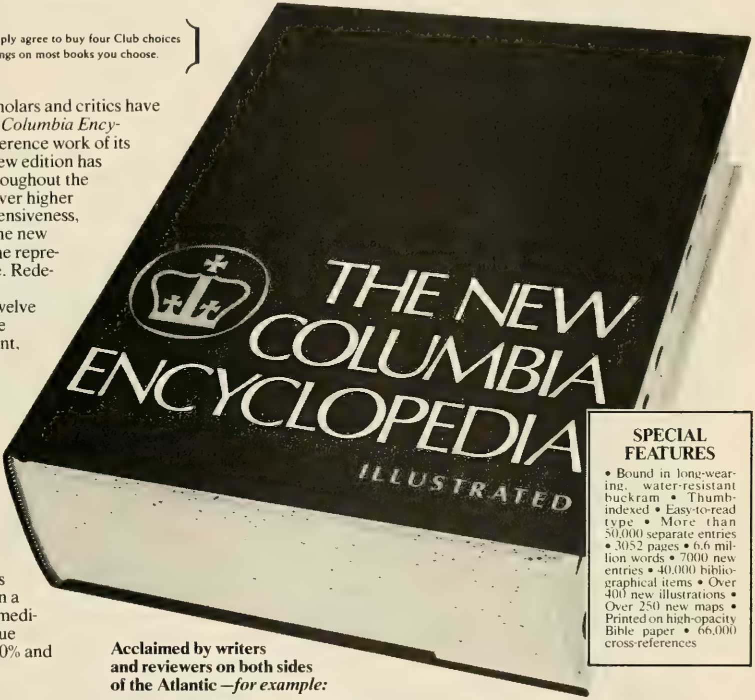

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I regard this tale as typical of scientific progress. New facts, collected in old ways under the guidance of old theories, rarely lead to any substantial revision of thought. Facts do not "speak for themselves"; they are read in the light of theory. Creative thought, in science as much as in the arts, is the motor of changing opinion. Science is a quintessentially human activity, not a mechanized, robotlike accumulation of objective information, leading by laws of logic to inescapable interpretation. I will try to illustrate this thesis with two examples drawn from the "classical" data for continental drift. Both are old tales that had to be undermined while drift remained unpopular.

I. The late Paleozoic glaciation. About 240 million years ago, glaciers covered parts of what is now South America, Antarctica, India, Africa, and Australia. If continents are stable, this distribution presents some apparently insuperable difficulties:

A. The orientation of striae in eastern South America indicates that the glacier moved onto the continent from what is now the Atlantic Ocean (striae are scratches on bedrock made by rocks frozen into glacier bottoms as they pass over a surface). The world's oceans form a single system, and transport of heat from tropical areas guarantees that no major part of the open ocean can freeze.

B. African glaciers covered what are now tropical areas.

C. Indian glaciers must have grown in semitropical regions of the Northern hemisphere; moreover, their striae indicate a source in tropical waters of the Indian Ocean.

D. There were no glaciers on any of the northern continents. If the earth got cold enough to freeze tropical Africa, why were there no glaciers in northern Canada or Siberia?

All these difficulties evaporate if the southern continents (including India) were joined together during this glacial period, and located farther south, covering the South Pole: the South American glaciers moved from Africa, not an open ocean; "tropical" Africa and "semitropical" India were near the South Pole; the North Pole lay in the middle of a major ocean, and glaciers could not develop in the Northern Hemisphere. Sounds good for drift; indeed, no one doubts it today.

II. The distribution of Cambrian trilobites (fossil arthropods living 500 to 600 million years ago). The Cambrian trilobites of Europe and North America divided themselves into two rather different faunas with the following peculiar distribution on modern maps. "Atlantic" province trilobites lived all over Europe and in a few very local areas on the far eastern border of North America—eastern (but not western) Newfoundland and southeastern Massachusetts, for example. "Pacific" province trilobites lived all over America and in a few local areas on the extreme western coast of Europe—northern Scotland and northwestern Norway, for example. It is devilishly difficult to make any sense of this distribution if the two continents always stood 3,000 miles apart.

But continental drift suggests a striking resolution. In Cambrian times, Europe and North America were separated: Atlantic trilobites lived in waters around Europe; Pacific trilobites in waters around America. The continents (now including sediments with entombed trilobites) then drifted toward each other and finally joined together. Later, they split again, but not precisely along the line of their previous junction. Scattered bits of ancient Europe, carrying Atlantic trilobites, remained at the easternmost border of North America, while a few pieces of old North America stuck to the westernmost edge of Europe.

Both examples are widely cited as "proofs" of drift today, but they were soundly rejected in previous years, not because their data were any less complete but only because no one had devised an adequate mechanism to move continents. All the original drifters imagined that continents plow their way through a static ocean floor. Alfred Wegener, the father of continental drift, argued early in our century that gravity alone could put continents in motion. Continents drift slowly westward, for example, because attractive forces of the sun and moon hold them up as the earth rotates underneath them. Physicists responded with derision and showed mathematically that gravitational forces are far too weak to power such a monumental peregrination. So Alexis du Toit, Wegener's South Af-
rican champion, tried a different t
He argued for a local, radioa
melting of oceanic floor at contine
borders, permitting the continen
glide through. This *ad hoc* hypoth
added no increment of plausibili
Wegener's speculation.

Since drift seemed absurd in
absence of a mechanism, ortho
geologists set out to render the
pressive evidence for it as a serie
unconnected coincidences.

In 1932, the famous American
ologist Bailey Willis strove to m
the evidence of glaciation compat
with static continents. He invoked
deus ex machina of "isthmian lin
—narrow land bridges flung with
ing abandon across 3,000 mile
ocean. He placed one between e
ern Brazil and western Africa,
other from Africa all the way to I
via the Malagasy Republic, an
third from Vietnam through Bo
and New Guinea to Australia.
colleague, Yale professor Cha
Schuchert, added one from Austr
to Antarctica and another from
arctica to South America, thus c
pleting the isolation of a south
ocean from the rest of the wor
waters. Such an isolated ocean m
freeze along its southern margin,
mitting glaciers to flow across
eastern South America. Its
waters would also nourish the
ciers of southern Africa. The Ind
glaciers, located above the equ
3,000 miles north of any southern
demanded a separate explanati
Willis wrote: "No direct connect
between the occurrences can reas
ably be assumed. The case must
considered on the basis of a gen
cause and the local geographic
topographic conditions." Willis's
ventive mind was equal to the ta
he simply postulated a topography
elevated that warm, wet south
waters precipitated their product
snow. For the absence of ice in te
perate and arctic zones of the No
ern Hemisphere, Willis reconstruc
a system of ocean currents that p
mitted him to postulate "a wa
subsurface current flowing northw
beneath cooler surface waters and
ing in the Arctic as a warm-wa
heating system." Schuchert was
lighted with the resolution provi
by isthmian links:

> Grant the biogeographer Holarc
> a land bridge from northern Afr
> to Brazil, another from So
> America to Antarctis (it alm

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exists today), still another
this polar land to Australia
from the latter across the Ara
Sea to Borneo and Sumatra an
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means of dispersal along shelf
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cal time on the basis of the pre
arrangement of the continents

The only common property sh
by all these land bridges was thei
terly hypothetical status; not an
of direct evidence supported any
of them. Yet, lest the saga of isthn
links be read as a warped fairy
invented by dogmatists to suppo
untenable orthodoxy, I point out
to Willis, Schuchert, and any ri
thinking geologist of the 1930s,
thing legitimately seemed ten ti
as absurd as imaginary land bri
thousands of miles long—contine
drift itself.

In the light of such highly fe
imaginations, the Cambrian trilob
could present no insuperable p
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thetical geometry for Cambrian oc
basins, geologists drew their m
and hewed to their orthodoxy.

When continental drift came
fashion during the late 1960s,
classical data from continental r
played no role at all: drift rode i
the coattails of a new theory, s
ported by new types of evidence.
physical absurdities of Wegen
theory rested in his conviction
continents cut their way through
ocean floor. But how else could c
occur? The ocean floor, the crus
the earth, must be stable. After
where could it go, if it move
pieces, without leaving gaping h
in the earth? Nothing could
clearer. Or could it?

"Impossible" is usually define
our theories, not given by nat
Revolutionary theories trade in
unexpected. If continents must p
through oceans, then drift will
occur; suppose, however, that co
nents are frozen into the oceanic c
and move passively as pieces of c
shift about. But we just stated that
crust cannot move without leav

. We reach an impasse that must idged by creative imagination, ist by another field season in the d Appalachians—we must l the earth in a fundamentally ent way.

e can avoid the problem of holes a daring postulate that seems to lid. If two pieces of ocean floor away from each other, they will no hole if material rises from arth's interior to fill the gap. We o further by reversing the casual cations of this statement: the f new material from the earth's ior may be the driving force that s old sea floor away. But since arth is not expanding, we must have regions where old sea floor ders into the earth's interior, thus rving a balance between cre- and destruction.

deed, the earth's surface seems broken into fewer than ten major tes,'' bounded on all sides by w zones of creation (oceanic s) and destruction (trenches). inents are frozen into these s, moving with them as the sea spreads away from zones of cre- at oceanic ridges. Continental is no longer a proud theory in its right; it has become a passive equence of our new orthodoxy— tectonics. Most geologists, my- included, have been over- med by the breadth of evidence late tectonics gathered from the ns during the past ten years—but st defer this tale for another time.

e now have a new, mobilist or- oxy, as definite and uncompro- ng as the staticism it replaced. In ght, the classical data for drift been exhumed and proclaimed roof positive. Yet these data d no role in validating the notion wandering continents; drift phed only when it became the ssary consequence of a new ry.

ne new orthodoxy colors our vi- of all data; there are no ''pure '' in our complex world. About years ago, paleontologists found ntarctica a fossil reptile named *rosaurus*. It also lived on South rica. If anyone had floated such gument for drift in the presence Villis and Schuchert, he would been howled down—and quite ctly. For Antarctica and South rica are almost joined today by ng of islands, and they were cer- y connected by a land bridge at us times in the past (a minor

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lowering of sea level would prod such a land bridge today). *Lys saurus* could have walked in comf on a rather short journey at that. the *New York Times* wrote an ed rial proclaiming, on this basis alc that continental drift had b proved.

Many readers may be disturbec my argument for the primacy theory. Does it not lead to dogmat and disrespect for fact? It can, course, but it need not. The lesso history holds that theories overthrown by rival theories, not orthodoxies are unshakable. In meantime, I am not distressed by crusading zeal of plate tectonics, two reasons. My intuition, cultur bound to be sure, tells me that i basically true. My guts tell me it's damned exciting—more t enough to show that conventic science can be twice as interesting anything invented by all the von nikens and in all the Bermuda tri gles of this and previous ages human gullibility.

Stephen Jay Gould teaches biolo geology, and the history of scienc Harvard University.

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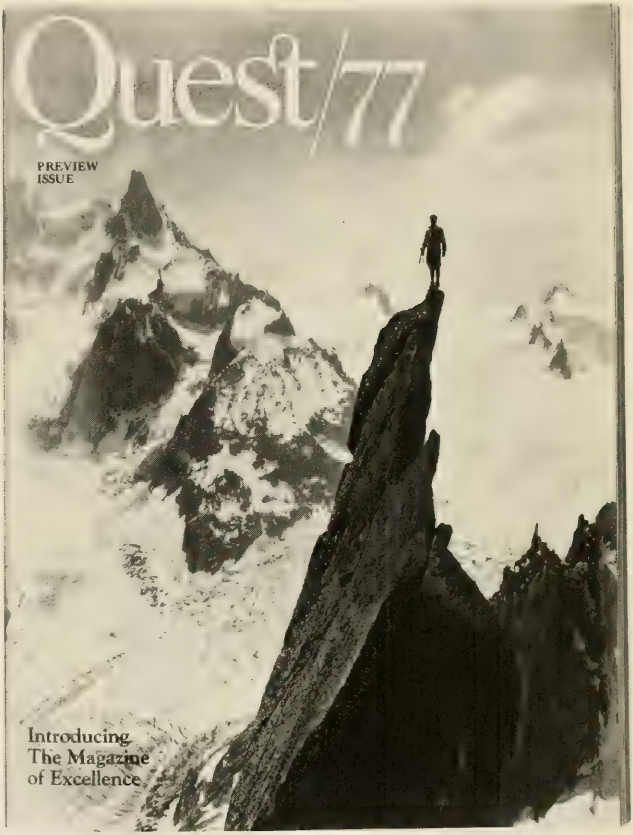

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Quest 77 **LIFE NEVER CEASES TO AMAZE.**

by Raymond Sokol

How to Treat the Common Cole

The cabbage and its kin are versatile vegetables

Mark Twain wrote: "Training is everything. The peach was once a bitter almond; cauliflower is nothing but cabbage with a college education." I used to think that was just a wisecrack about a vegetable the old wag didn't like, but Twain was, it turns out, literally correct about cauliflower. It *is* a descendant of the common cabbage. In fact, it is a cultivated variant of the very same species, *Brassica oleracea.*

More remarkable still, the same Protean plant is just as intimately related to Brussels sprouts, kale, broccoli, and kohlrabi. They are all cultigens (varieties known only in cultivated form) of *B. oleracea.* Each plant does have its own varietal name. Cabbage is *capitata* (a surname that includes green, red, and Savoy cabbage). Kale is *acephala.* Both cauliflower and broccoli are lumped together as *B. oleracea botrytis.* And so on, in a series of seemingly well-ordered appellations, but even they do not begin to nail down the surprising diversity produced by human attention to one wild, leafy weed very long ago.

What is genuinely hard to see at first is how so many apparently dissimilar vegetables could be so closely connected. It turns out that each is a highly specialized distortion of the original wild type, which was a protokale native to the seacoasts of Europe's North Temperate Zone. The genus *Brassica* includes many other useful plants: rutabaga, turnip, various mustard greens, and bok choy. But none of them lent itself to human hydridization so brilliantly as *B. oleracea.* The most useful of these artificial freaks, the cabbage, was coaxed to grow a very short stem and lots of leaves that overlap and appear to form a huge bud. Real buds of *B. oleracea* (axillary buds grown on an erect stem) have been trained to develop into heads—what we know as Brussels sprouts—instead of sprouting normally into branches. Kohlrabi is a headless stem swollen into a mass of edible tissue. Cauliflower and broccoli are both examples of a stunted inflorescence, heads of abortive flowers on thick, hypertrophied branches.

It is as if a mad agronomist had set out to magnify and bloat the various organs of an inoffensive weed and then had found that each mutation was more attractive than the last. Of course, cultivation of the cabbage kin must have stretched over a long period and seems to have occurred primarily in prehistoric times. True cabbage, as well as cauliflower and broccoli, was known to the Greeks and Romans. The poet Propertius, in the persona of Vertumnus, god of vegetation and the changing seasons, wrote: "I am famous for the green cucumber, and the swelling belly of the gourd and for the cabbage tied with light rushes."

Germans, Saxons, and Celts brought the *oleracea* cultigens
Great Britain, where the speci
original native variety, a stout per
nial called colewort, still grows wi
The word *cole* also survives, as
all-purpose name for members of
Brassica genus. It is obviously c
nected, linguistically, with kale
cauliflower and with the Germ
word for cabbage, *Kohl.* Kohlrab
Austrian dialect for cabbage-tur
(standard German for turnip is *Rüb*
So, for once, popular nomenclat
reflects botanic reality; reflects it,
fact, more accurately than the conf
ing, if official, binomial monicker

Cole, at any rate, is the oldest te
we have in English for cabbage.
appears in an Anglo-Saxon sou
dated about 1000. And it is in co
mon usage in the phrase "cole slaw
cabbage salad. Nevertheless, un
all other circumstances, we call
oleracea v. *capitata* just plain c
bage. The earliest written source
the word is a cookbook printed
1440, which directs us to "take
baches and cut ham on foure . . .
let hit boyle." This is good adv
and it also shows the French origin
the word cabbage. *Caboche* is Fre
slang for a "big head," a nogg
Cabbages are big heads, and the jo
ney from caboche to cabache to c
bage is a short and direct one.

Today, cabbage and its spec
mates grow almost everywhere in
world except the tropics. They
easy to cultivate, do well in c
weather, and yes, they are good
you. Nutritionally, cabbage is m

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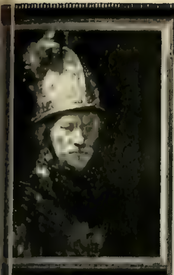

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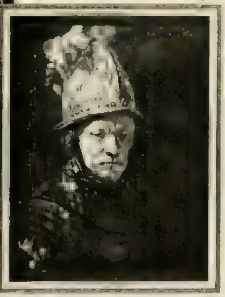

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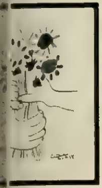

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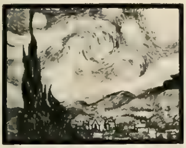

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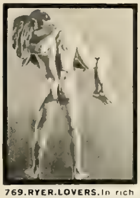

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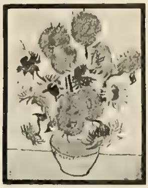

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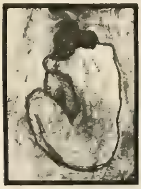

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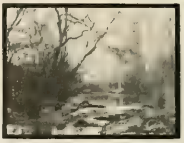

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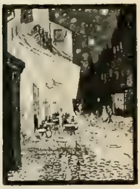

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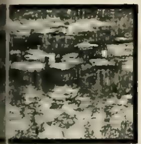

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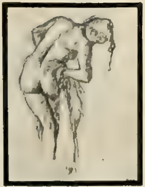

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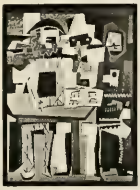

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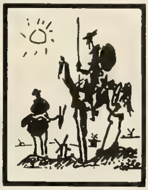

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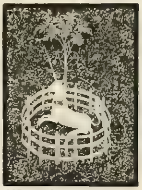

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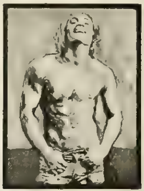

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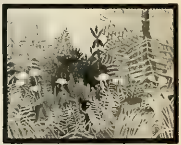

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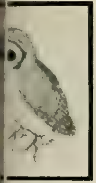

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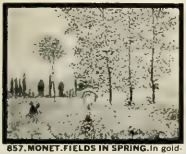

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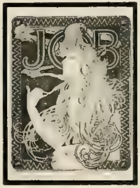

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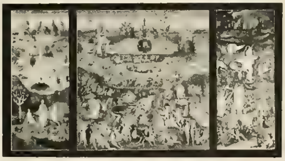

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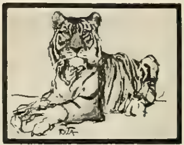

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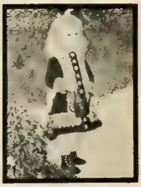

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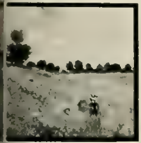

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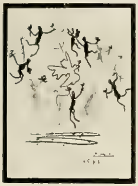

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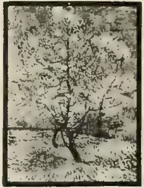

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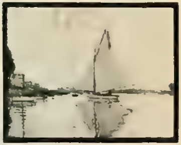

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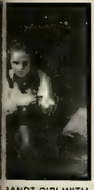

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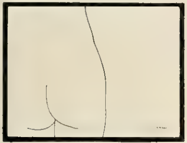

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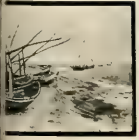

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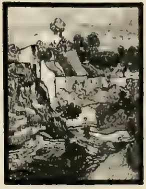

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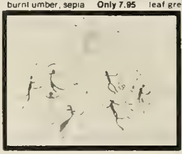

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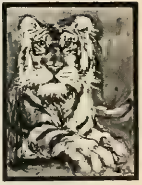

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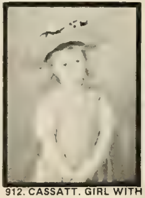

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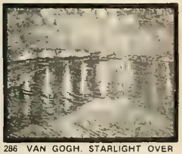

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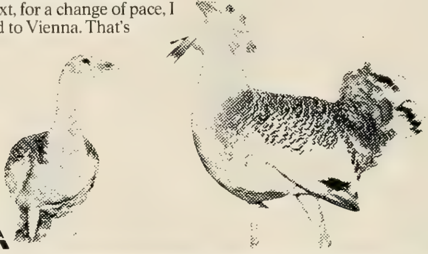

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than 90 percent water, but it is low in calories (only 24 per grams, or 3½ ounces, of raw bage) and high in vitamin A and min C. Kale is phenomenally hig vitamin C, with 186 milligrams 100 grams. An orange averages 50 milligrams per 100 grams peeled fruit.

More enticing, perhaps, to the sumer than all this nutritional boning is the welcome news, cabbage et al. can be prepare dozens of brilliantly delicious w starting with the moderately s Szechwan recipe for broccoli bel The stir-fry method keeps the veg ble from stewing its way to insipic as does the addition of dried red pers and fresh ginger to the sa You may also use cauliflower fo recipe. Not only do the Chinese th selves practice this taxonomic plausible substitution, but they the same name to both caulifle and broccoli, *huacai*.

If you were brought up thinkin cabbage as a malodorous penalty gave you gas, you will be please perhaps jealous to learn that e simple French households got arc the dreadful sight of gray masse steamed leaves by pureeing cabl with an equal weight of boiled p toes, dehydrating out excess mois from the puree in a hot oven, and serving it with butter. Almost e culture but ours has a cabbage s combining meat, cabbage, and o vegetables. My grandmother ca this soup borscht and made it beef. In the Pyrenees, they use p and call it *garbure*.

For real cabbage versatility, h ever, we face east, toward Budap George Lang's *The Cuisine of H gary* lists a score of dishes, from basic stuffed cabbage to a lea concoction of pâté and crinkly Sa cabbage. Hungary is also a place does not snub the kohlrabi, but c fully scoops out the centers, ch them together with the leaves uses the mixture as a sauce (aft has been cooked and seasoned) to over the kohlrabi shells, which th selves are stuffed with a mixtur ground veal and pork and then bal

For some reason, kohlrabi rec tend to be complicated. But I disc ered recently, having returned fro farm stand with four small and te ones, that they can be peeled, sl thinly, and sautéed in no time. result is very appealing. They done when they turn an opaque wh

The new, improved 1977 Natural History Photographic Competition

The greatest photographic mpetition in the history of *tural History* is on. The and Prize is a round trip for o to Peru, a country that will allenge any photographer th vistas of ancient royal ies, Andean peaks, Amazon- jungles, deserts, fog- rouded coasts, and a colorful xture of peoples. The cash

izes this year total more than ,000. And the winning en- es will be published in a ecial double issue of *Natural istory* in August and will be own at The American useum of Natural History.

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The deadline is April 15, 1977. Please put your name and address on every entry, and include a stamped, self-addressed envelope—since we do want to return your pictures to you.

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The Rules

1. The competition is open to everyone except employees of The American Museum of Natural History and their kin.

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Cabbage and company (Brusse
sprouts and kohlrabi excepted) c
also be eaten raw, ideally with *aïo*
a garlic-laden mayonnaise, to accor
pany the shredded leaves or crunc
flowerets. Red cabbage, shredd
and mixed with plain yogurt, mak
a Lucullan, filling dish for a dieter
lunch or for anyone in search of
unappalling source of roughage.

For more exotic moments, try ca
liflower pakoris, a sort of Indian ter
pura with a chickpea-flour batter. C
the flowerets into 1-inch segment
Then mix together—as Madhur Ja
frey suggests in *An Invitation to I*
dian Cuisine—1 cup sifted chickp
flour, ¼ teaspoon each of salt, grou
turmeric, ground cumin, and baki
soda with ⅛ teaspoon each of bla
and cayenne pepper. Dip t
flowerets in the batter and fry a fe
at a time, slowly, in oil, until gold
brown.

Thus surfeited, you will permit m
to close with a few random and de
cious tidbits about Cabbage a
Sons:

The white part of the cauliflow
is known as its "curd."

Sauerkraut is shredded cabba
fermented by the action of lactobaci
on the natural sugars in the cabba
juice. This produces lactic acid, wi
its characteristically sour taste, a
preserves the cabbage, turning it in
what one authority calls "human s
lage." This mash is, to my mind, pa
atable only as a stuffing for turkey
the Serbian dish, *podvarak* (see *Na*
ural History, November 1975).

English slang expressions th
refer to cabbage are almost alwa
pejorative: cabbagehead for foo
cabbage-leaf for a cheap cigar.
French, on the other hand, *ch*
("cabbage") is a term of endea
ment. "To have something in yo
cabbage" (*en avoir dans le cho*
means to be intelligent. And it is ha
to think of *pâte à chou* ("cream pu
dough," but, literally, "cabba
dough") as anything but pleasant.

American farmers produce rough
2 billion pounds of cabbage in a no
mal year. They also grow 350 milli
pounds of broccoli, 73 milli
pounds of Brussels sprouts, and 3
million pounds of cauliflower. Y
have your work cut out for you.

Chao Jielucai

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book, by Ellen Schrecker with Jo
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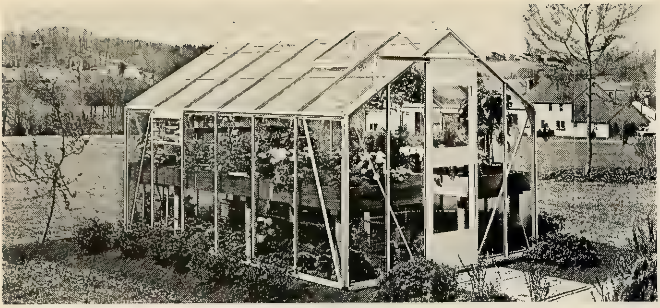

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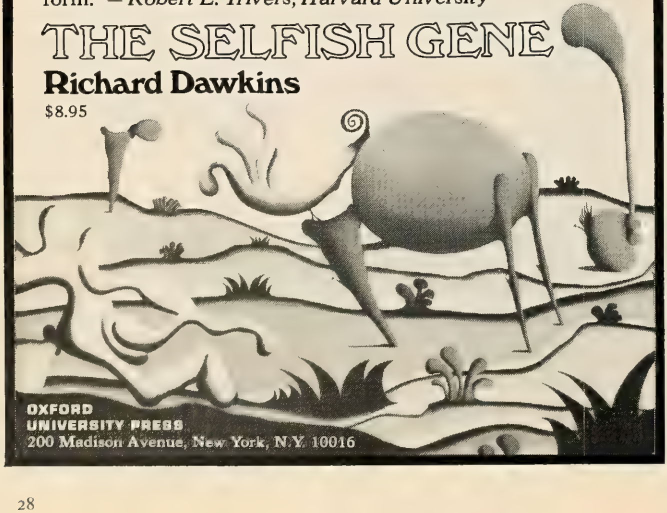

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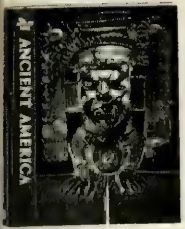
1 large bunch broccoli
3 dried red peppers
½-inch piece fresh ginger
1 tablespoon cornstarch
¼ cup peanut oil
1 teaspoon salt

1. Wash the broccoli. Cut t flowerets off the main stems fairly good-size pieces. Cut the tough bottom part of t stems, then slice the stems in h lengthwise and then into pie about 2 inches long.
2. Cut each pepper into 4 pieces
3. Peel the ginger, then cut i shreds about ⅛ inch wide, t width of a wooden matchstick
4. Combine the cornstarch with cup water in a bowl and set asi
5. Heat your wok or pan over a hi flame for 15 seconds, then a the oil. It will be ready to co with when the first tiny bubb form and a few small wisps smoke appear.
6. When the oil is ready, throw the ginger and the red peppe Use your cooking shovel spoon to stir them around in t middle of the pan for 5 secon
7. Now add the broccoli and stir-f for 1½ minutes, scooping it the sides of the pan and stirri it around in the middle so eve piece is exposed to the hot oil
8. Add the salt and stir-fry the bro coli for 1 minute longer.
9. Pour ⅔ cup water into the pa wait for it to come to a boil, th cover the pan and let the brocc cook over a moderately hi flame for 8 minutes.
10. Stir the cornstarch and water make sure they are well co bined; then, just before you a ready to serve the broccoli, po the mixture into the pan. Stir-f the broccoli for a few secon over a high flame until the sau turns thick and clear, then serv

Note: One small head of cauliflow can be substituted for the broccoli this recipe. There is no simple w to calculate the number of portio this dish will serve. You must deci whether it is a side dish in a Weste meal or one of many dishes of mor or-less equal importance in a Chine meal. Four servings is a rough gue for either situation.

Raymond Sokolov's most rece cookbook is The Saucier's Appre tice, *a guide to French sauces.*



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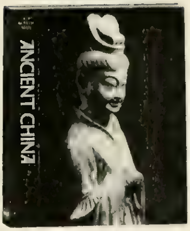

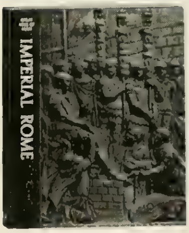

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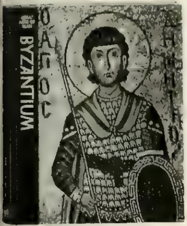

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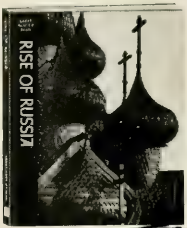

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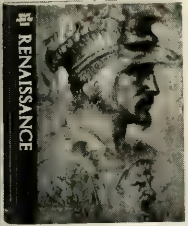

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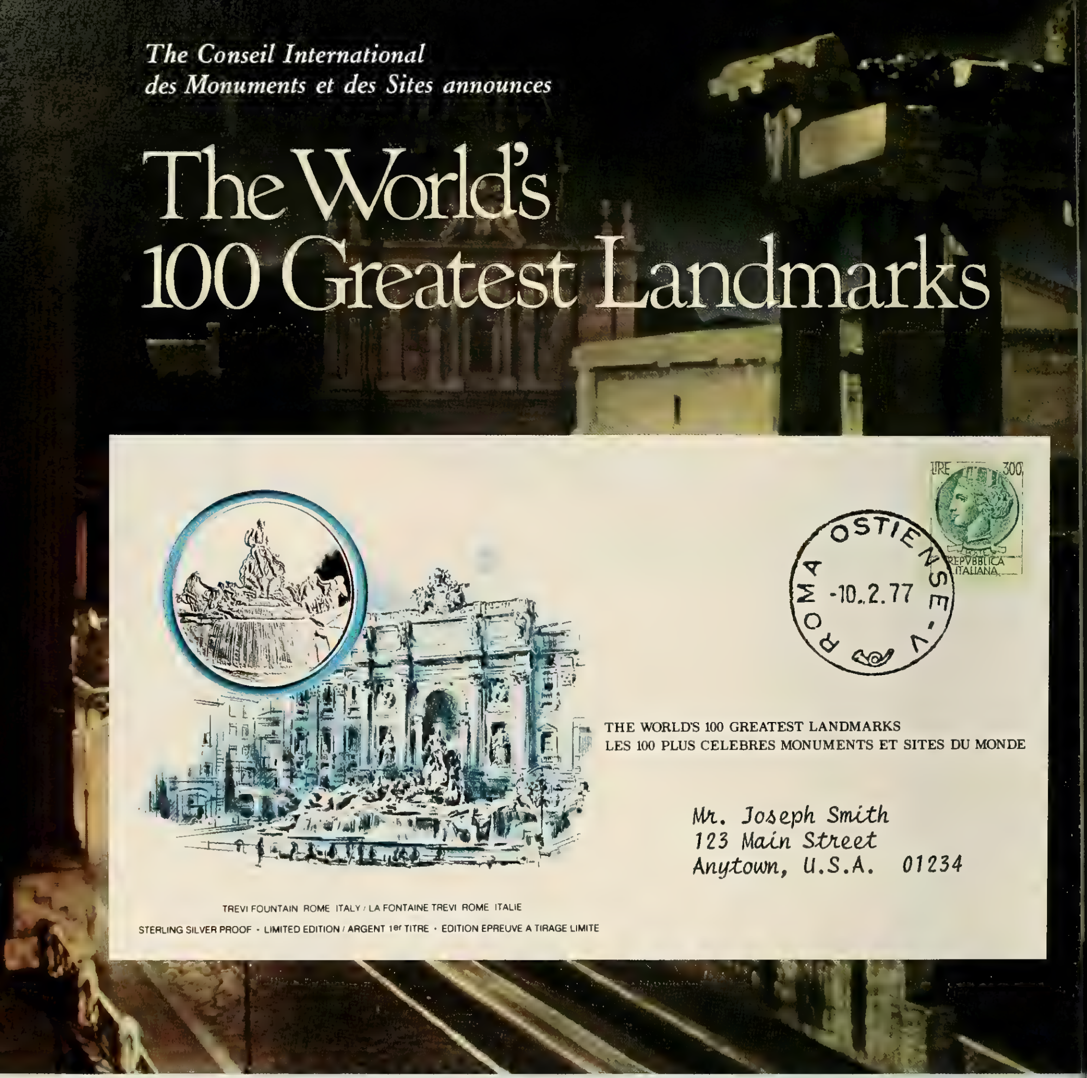
The Conseil International des Monuments et des Sites announces

The World's 100 Greatest Landmarks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by Richard Dawki

The Remarkable Replicators

We are simply their well-run survival machines

It is difficult enough explaining how even a simple universe began. I take it as agreed that it would be even harder to explain the sudden springing up, fully armed, of complex order—life. Darwin's theory of evolution by natural selection is satisfying because it shows us a way in which simplicity could change into complexity, how unordered atoms could group themselves into ever more complex patterns until they ended up manufacturing people. Darwin provides a solution, the only feasible one so far suggested, to the deep problem of our existence.

Darwin's "survival of the fittest" is really a special case of a more general law of *survival of the stable.* The universe is populated by stable things. A stable thing is a collection of atoms which is permanent enough or common enough to deserve a name. It may be a unique collection of atoms, such as the Matterhorn, which lasts long enough to be worth naming. Or it may be a *class* of entities, such as raindrops, which come into existence at a sufficiently high rate to deserve a collective name, even if any one of them is short-lived.

The things which we see around us, and which we think of as needing explanation—rocks, galaxies, ocean waves—are all, to a greater or lesser extent, stable patterns of atoms. Soap bubbles tend to be spherical because this is a stable configuration for thin films filled with gas. In a spacecraft, water is also stable in spherical globules, but on earth, where there is gravity, the stable surface for standing water is flat and horizontal. Salt crystals tend to be cubes because this is a stable way of packing sodium and chloride ions together. In the sun the simplest atoms of all, hydrogen atoms, fuse to form helium atoms because in the conditions which prevail there the helium configuration is more stable. Other even more complex atoms are formed in stars all over the universe, and were formed in the "big bang," which according to the prevailing theory, initiated the universe. This is originally where the elements on our world came from.

Sometimes when atoms meet they link up together in chemical reactions to form molecules that may be more or less stable. Such molecules can be very large. A crystal such as a diamond can be regarded as a single molecule, a proverbially stable one in this case, but also a very simple one since its internal atomic structure is endlessly repeated. In modern living organisms there are other large molecules which are highly complex, and their complexity shows itself on several levels. The hemoglobin of our blood is a typical protein molecule. It is built up from chains of smaller molecules, amino acids, each containing a few dozen atoms arranged in a precise pattern. In the hemoglobin molecule there are 574 amino acid molecules. These are arranged in four chains, which twist around each other to form a globular three-dimensional structure of bewildering complexity. A model of a hemoglobin molecule looks rather like a dense thornbush. But unlike a real thornbush it is not a haphazard approximate pattern but a definite invariant structure, identically repeated, with not a twig or a twist out of place, over six thousand million million million times in an average human body. The precise thornbush shape of a protein molecule such as hemoglobin is stable in the sense that two chains consisting of the same sequences of amino ac
will tend, like two springs, to co
to rest in exactly the same thr
dimensional coiled pattern. Hem
globin thornbushes are springing i
their "preferred" shape in your bo
at a rate of about four hundred milli
million per second, and others
being destroyed at the same rate.

Hemoglobin, a modern molecu
illustrates the principle that ato
tend to fall into stable patterns. B
fore the coming of life on earth, so
rudimentary evolution of molecu
may have occurred by ordinary pr
esses of physics and chemist
There is no need to think of desi
or purpose or directedness. If a gro
of atoms in the presence of ener
falls into a stable pattern, it will te
to stay that way. The earliest form
natural selection was simply a sel
tion of stable forms and a rejection
unstable ones. There is no myste
about this. It had to happen by defi
tion.

From this, of course, it does r
follow that you can explain the exi
ence of entities as complex as man
exactly the same principles on th
own. It is no good taking the rig
number of atoms and shaking the
together with some external ener
till they happen to fall into the rig
pattern and out drops Adam! Y
may make a molecule consisting o
few dozen atoms like that, but a m
consists of over a thousand milli
million million million atoms.
try to make a man, you would ha
to work at your biochemical cockt
shaker for a period so long that t
entire age of the universe would see

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American Museum of Natural History Announces an Extraordinary Adriatic-Aegean Cruise

On September 19, 1977, 255 fortunate (and foresighted) friends of the American Museum will embark on a voyage to the splendid past...the glories of ancient Greece and Byzantium...interspersed with quiet days on unspoiled islands, in the favorite haunts of rare and beautiful birds.

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The company you'll keep includes a group of distinguished lecturers who will lead discussions, travel with you, share their own enthusiasms. There are six in all, including the American Museum's director, Dr. Thomas D. Nicholson. Two Museum ornithologists will concentrate on the bird life (they plan to take you to Scutari in Turkey, the best of all possible places to watch the spectacular Fall migration of thousands of birds). An Oxford don, a Brown University archeologist, the former director of the British Museum will share the honors when you're visiting archeological digs or admiring works of art.

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Please send an itinerary and other information about the Adriatic-Aegean Cruise

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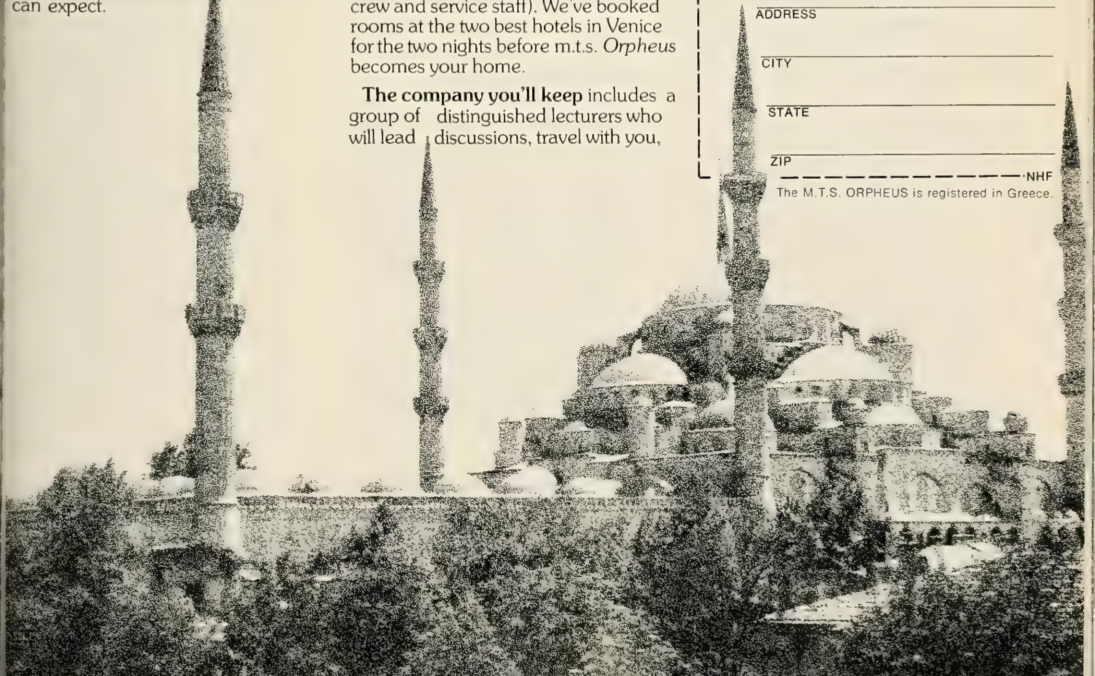

like an eye blink, and even then you would not succeed. This is where Darwin's theory, in its most general form, comes to the rescue. Darwin's theory takes over from where the story of the slow building up of molecules leaves off.

The account of the origin of life I shall give is necessarily speculative; by definition, nobody was around to see what happened. There are a number of rival theories, but they all have certain features in common. The simplified account I shall give is probably not too far from the truth.

We do not know what chemical raw materials were abundant on earth before the coming of life, but among the plausible possibilities are water, carbon dioxide, methane, and ammonia—all simple compounds known to be present on at least some of the other planets in our solar system. Chemists have tried to imitate the chemical conditions of the young earth. They have put these simple substances in a flask and supplied a source of energy such as ultraviolet light or electric sparks—artificial simulation of primordial lightning.

After a few weeks of this, something interesting is usually found inside the flask: a weak brown soup containing a large number of molecules more complex than the ones originally put in. In particular, amino acids—the building blocks of proteins, one of the two great classes of biological molecules—have been found. Before these experiments were done, naturally occurring amino acids would have been thought of as diagnostic of the presence of life. If they had been detected on, say, Mars, life on that planet would have seemed a near certainty. Now, however, their existence need imply only the presence of a few simple gases in the atmosphere and some volcanoes, sunlight, or thundery weather. More recently, laboratory simulations of the chemical conditions of earth before the coming of life have yielded organic substances called purines and pyrimidines. These are building blocks of the genetic molecule, DNA itself.

Processes analogous to these must have given rise to the "primeval soup" that biologists and chemists believe constituted the seas some three to four thousand million years ago. The organic substances became locally concentrated, perhaps in drying scum round the shores or in tiny suspended droplets. Under the further influence of energy, such as ultraviolet light from the sun, they combined into larger molecules. Nowadays, large organic molecules would not last long enough to be noticed; they would be quickly absorbed and broken down by bacteria or other living creatures. But bacteria and the rest of us are latecomers, and in those days, large organic molecules could drift unmolested through the thickening broth.

At some point a particularly remarkable molecule was formed by accident. We will call it the *replicator*. It may not necessarily have been the biggest or the most complex molecule around, but it had the extraordinary property of being able to create copies of itself. This may seem a very unlikely sort of accident to happen. So it was. It was exceedingly improbable. In the lifetime of a man, occurrences that improbable are practically impossible. That is why you will never win a big prize on the football pools. But in our human estimates of what is probable and what is not, we are not used to dealing in hundreds of millions of years. If you filled in pool coupons every week for a hundred million years you would likely win several jackpots.

Actually, a molecule which makes copies of itself is not as difficult to imagine as it seems at first, and it only had to arise once. Think of the replicator as a mold or template. Imagine it as a large molecule consisting of a complex chain of various sorts of building block molecules. The small building blocks were abundantly available in the soup surrounding the replicator. Now suppose that each building block has an affinity for its own kind. Then whenever a building block from out in the soup lands up next to a part of the replicator for which it has an affinity, it will tend to stick there. The building blocks that attach themselves in this way will automatically be arranged in a sequence that mimics that of the replicator itself. It is easy then to think of them joining up to form a stable chain just as in the formation of the original replicator. This process could continue as a progressive stacking up, layer upon layer. This is how crystals are formed. On the other hand, the two chains might split apart, in which case we have two replicators, each of which can go on to make further copies.

A more complex possibility is that each building block has affinity, not for its own kind, but reciprocally one particular other kind. Then replicator would act as a template, for an identical copy, but for a k of "negative," which would in turn remake an exact copy of the or inal positive. For our purposes it d not matter whether the original re cation process was positive–negat or positive–positive, although it worth remarking that the mod equivalents of the first replicator, DNA molecules, use positive–ne tive replication.

What does matter is that sudde a new kind of "stability" came i the world. Probably no particu kind of complex molecule was p viously very abundant in the so because each was dependent building blocks happening to fall luck into a particular stable config ration. As soon as the replicator w born it must have spread its cop rapidly throughout the seas, until smaller building block molecules b came a scarce resource, and ot larger molecules were formed m and more rarely.

So we seem to arrive at a large p ulation of identical replicas. But n we must mention an important pr erty of any copying process: it is perfect. Mistakes will happen. I ho there are no misprints in this mag zine, but if you look carefully y may find one or two. They will prob bly not seriously distort the meani of the sentences because they will "first generation" errors. But ima ine the days before printing, wh books such as the Gospels we copied by hand. All scribes, howev careful, are bound to make a f errors, and some are not above a lit willful "improvement." If they copied from a single master origin meaning would not be greatly p verted. But let copies be made fr other copies, which in their turn we made from other copies, and err will start to become cumulative a serious.

We tend to regard erratic copyi as a bad thing, and in the case human documents, it is hard to thi of examples where errors can be d scribed as improvements. I suppo the scholars of the Septuagint cou at least be said to have started som thing big when they mistranslated t Hebrew word for "young woma into the Greek word for "virgin. coming up with the prophecy: "B hold a virgin shall conceive and be a son. . . ." Anyway, as we sh erratic copying in biological icators can in a real sense give rise nprovement, and it was essential the progressive evolution of life some errors were made.

/e do not know how accurately original replicator molecules e their copies. Their modern de- dants, the DNA molecules, are nishingly faithful compared with nost high-fidelity human copying ess; but even they occasionally e mistakes, and it is ultimately e mistakes which make evolution sible. Probably the original repli- rs were far more erratic, but in case we may be sure that mistakes e made and these mistakes were ulative.

s miscopyings were made and agated, the primeval soup be- e filled by a population, not of tical replicas, but of several eties of replicating molecules, all scended'' from the same ances- Would some varieties have been e numerous than others? Almost ainly yes. Some varieties would e been inherently more stable than rs. Certain molecules, once ned, would be less likely than rs to break up again. These types ld become relatively numerous in soup, not only as a direct logical sequence of their ''longevity,'' also because they would have a g time available for making copies themselves. Replicators of high gevity would therefore tend to be- e more numerous and, other gs being equal, there would have n an ''evolutionary trend'' toward ater longevity in the population of lecules.

ut other things were probably not al, and another property of a repli- r variety, which must have had n more importance in spreading it ugh the population, was speed of lication, or ''fecundity.'' If repli- r molecules of type A make ies of themselves, on average, e a week while those of type B ke copies of themselves once an r, pretty soon type A molecules going to be far outnumbered, even hey ''live'' much longer than B lecules. There would therefore bably have been an evolutionary d toward higher fecundity of mol- les in the soup.

A third characteristic of replicator lecules that would have been posi- ly selected is accuracy of replica- n. If molecules of type X and type last the same length of time and

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replicate at the same rate, bu
makes a mistake, on average, e
tenth replication while Y make
mistake only every hundredth re
cation, Y will obviously bec
more numerous. The X continger
the population loses not only the
rant "children," but also all their
scendants, actual or potential.

The primeval soup must have
come populated by stable varietie
molecules: stable in that either the
dividual molecules lasted a long t
or they replicated rapidly or they
licated accurately. Evolution
trends toward these three kinds of
bility took place in the follow
sense: if you had sampled the sou
two different times, the later sam
would have contained a hig
proportion of varieties with h
longevity/fecundity/copying fidel
This is essentially what a biolo
means by evolution when he is spe
ing of living creatures, and the me
anism is the same—natural selecti

Should we then call the origi
replicator molecules "living"? W
cares? Whether we call the ea
replicators living or not, they w
the ancestors of life, they were
founding fathers.

The next important link in the ar
ment, one which Darwin himself l
stress on (although he was talk
about animals and plants, not mo
cules) is *competition*. The prime
soup was not capable of supporting
infinite number of replicator mo
cules. For one thing, the earth's s
is finite, but other limiting fact
must also have been important. In
picture of the replicator acting a
template or mold, we supposed it
be bathed in a soup rich in the sm
building block molecules necess
to make copies. But when the repli
tors became numerous, buildi
blocks must have been used up
such a rate that they became a sca
and precious resource. Differ
varieties or strains of replicator m
have competed for them. Le
favored varieties must actually ha
become *less* numerous because
competition, and ultimately many
their lines must have gone extin
There was a struggle for exister
among replicator varieties. They
not know they were struggling
worry about it; the struggle was c
ducted without any hard feelings,
deed, without feelings of any kir
But they were struggling, in the ser
that any miscopying that resulted
a new, higher level of stability o

v way of reducing the stability of als was automatically preserved l multiplied.

The process of improvement was nulative. Ways of increasing sta- ty and of decreasing rivals' stabil- became more elaborate and more cient. Some of them may even ve "discovered" how to break up lecules of rival varieties chemi- ly and to use the building blocks released for making their own ies. These protocarnivores simul- eously obtained food and removed npeting rivals. Other replicators haps discovered how to protect mselves, either chemically or by lding a physical wall of protein und themselves. This may have n how the first living cells ap- red.

Replicators began not merely to st but to construct for themselves ntainers, vehicles for their contin- l existence. The replicators that vived were the ones that built urvival machines" for themselves live in. The first survival machines obably consisted of nothing more n a protective coat. But making a ing got steadily harder as new als arose with better and more ef- tive survival machines. Survival chines became bigger and more borate, and the process was cumu- ive and progressive.

Was there to be any end to the grad- l improvement in the techniques d artifices used by the replicators to ure their own continuance in the rld? There would be plenty of time improvement. What weird en- es of self-preservation would the llennia bring forth? Four thousand llion years on, what was to be the e of the ancient replicators?

They did not die out, for they are st masters of the survival arts. But not look for them floating loose in sea; they gave up that cavalier edom long ago. Now they swarm huge colonies, safe inside gigantic mbering robots, sealed off from the tside world, communicating with it tortuous indirect routes, manipu- ing it by remote control. They are you and in me; they created us, dy and mind; and their preser- tion is the ultimate rationale for our istence. They have come a long ay, those replicators. Now they go the name of genes, and we are their rvival machines.

ichard Dawkins is a lecturer in ani- al behavior at Oxford University.

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Baltimore Orioles

by Gilroy Roberts

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ımore Orioles—Shown actual size.
sculpture portrays a female Oriole
her young in a family grouping
acteristic of this very domestic bird.

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Rock Art and the Power of Shamans

by Dean R. Snow

Intricate designs, symbols, and imaginary animals attest to the importance many American Indian societies placed on the supernatural

Here and there across North America, rock art, carved or painted by Indians many years ago, proliferates on smooth cliffs, outcroppings, boulders, and caves. Petroglyphs are more common than paintings, many of which have eroded away. Both, however, consist of human and animal representations and symbols of varying degrees of complexity.

The increasing publicity given in recent years to the location of these intriguing signs of native American culture has resulted in the illicit quarrying and sale of this art. But it has also spurred a desire for preservation and protection and has given anthropologists an opportunity to consider the more subtle characteristics of long since vanished Indian cultures.

This is not to say that anthropologists have been notably successful in interpreting rock art. Until recently, most studies usually compared superficial inventories of motifs found on figures at one site with lists of those from other sites. Such lists included birds, bird tracks, horned humans, fish, and various other human, animal, or abstract figures.

Although painted or carved in a simple style, many of these figures and shapes defy precise identification. Animal representations may symbolize a dog, a bear, or any one of several other quadrupeds. Even more frustrating is the frequent juxtaposition of animal figures, some unfinished, with abstract symbols. There are exceptions to the general simplicity, such as the lavish Chumash paintings in southern California, near Santa Barbara, but clean lines characterize the contents of most rock art sites.

Anthropologists have often interpreted rock art as examples of picture writing (pictographs), assuming that the artist consciously intended to enliven and clarify oral literature. But efforts to read the figures at petroglyph and pictograph sites as if they were narrative statements have consistently failed.

Only a few people studying Indian rock art have suggested that each figure was an entity in itself, bearing no relationship to other nearby figures. Also, there has rarely been an attempt to consider rock art figures in the light of our historical knowledge of various American Indian cultures. To suggest, for example, that rock art was the result of a belief in hunting magic would be futile if historical literature did not mention some form of a belief in such magic.

I was first attracted to the study of petroglyphs as a teen-ager growing up in a small town in southern Minnesota. The land there was once prairie, flattened by a succession of Ice Age glacial advances and now creased by the tributary streams of the Mississippi River. Over most of the area, bedrock lies buried deep under the sand and gravel drift left behind by the glaciers, but occasionally a dome of red Sioux quartzite pokes through the surface. One such outcrop lies like the back of a great red whale in a sea of prairie grass in rural Cottonwood County. The surface of the nearly horizontal rock face bears ripple marks left by the waves of the Precambrian sea as well as a multitude of north–south scratches cut by the glaciers that passed over it millions of years later. The rock face also bears an array of petroglyphs, which are far more difficult to explain than the ripple marks and glacial scratches.

The bedrock surfaces again at Pipestone about sixty miles to the west near the Minnesota–South Dakota border. For centuries, prehistoric Indians came to this area to quarry pipestone, the fine-grained red rock we call catlinite, for the bowls of their long smoking pipes. Even though this attractive raw mater occurs in only a few places; finish pipes have been discovered in ma Indian sites in eastern Nor America.

The quarry near the border was o of the largest, and its importance w underscored by the dozens of petr glyphs that once adorned the rock su face. The existence of the quarr however, provides us with only t most general reason for the petr glyphs. For a more specific explan tion, we must look to the historic record of the Siouan-speaking Dakc Indians and their ancestors w monopolized the resource for ce turies.

An important part of Dakota cu ture, particularly for men, was the v sion quest. This typically involv periods of isolation, fasting, and ev self-torture by young men in sear of hallucinations that they regarded guideposts for their future live Their chances of having such expe ences were increased if they attach themselves to shamans—older m whose supernatural powers were we known. In their search they oft smoked pipes of the strong native t bacco, a potent inducer of hallucin tions. There was thus a strong co nection linking the pipestone quarri to the supernatural activities of D kota shamans and their apprentices

Historical records indicate that D kota Indians believed the Pipesto petroglyphs to be of supernatural or gin. One story has it that a huge thu derbird carved the petroglyphs wi lightning bolts. Such explanatio

Representations of bighorn shee such as these in Monument Valle Arizona, occur by the thousan in the western United States. Th were probably painted by Indi hunters practicing shamanis

Elliot Erw

may seem quaint to us, for contemporary Western culture draws a clear line between the natural and the supernatural. But in the traditional Dakota culture, concepts of natural and supernatural were elaborately intertwined. The petroglyphs were probably made by a shaman or his apprentice responding to a vision of a thunderbird. But in a culture in which shamanistic power was assumed to exist as a natural component of life, the connection between the vision as an impetus and the petroglyphs as a result is entirely logical.

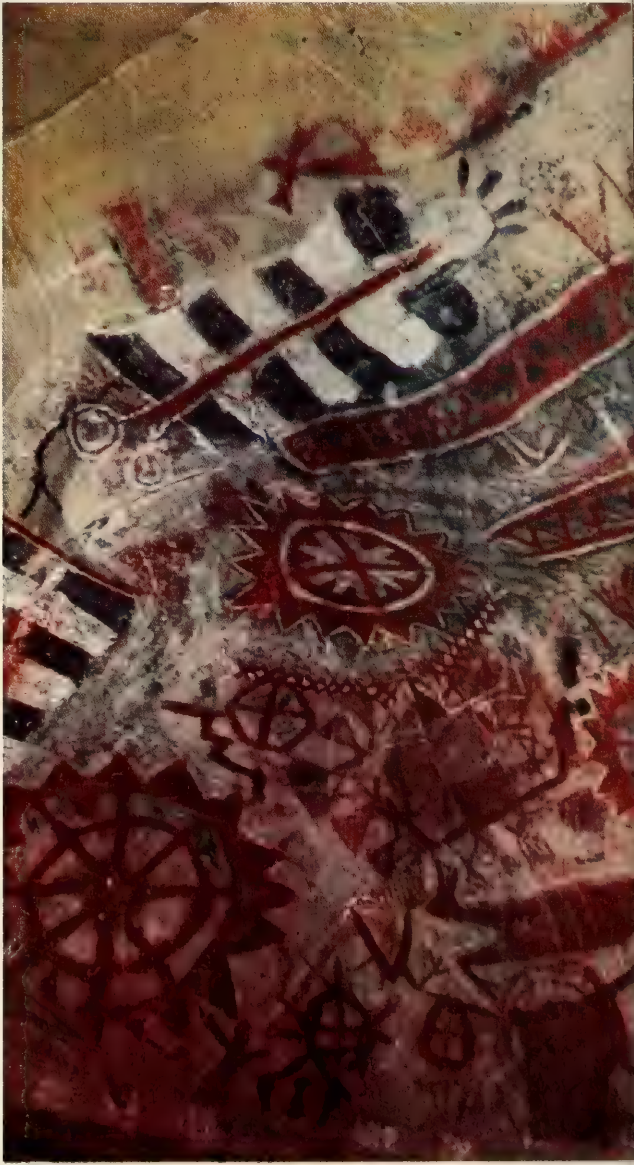
Shamans were usually men, occasionally women, and always strong personalities. By virtue of this trait and their ability to conjure up visions for themselves and others, they served to integrate the natural and supernatural in Dakota society. The Dakota believed that birds, turtles, deer, fish, humans, and other petroglyph motifs had an inherent magical power of their own because they often saw them in visions.

The notion of art possessing inherent power is also evident in the sand paintings of the Navajo, who believed that the curing power they transmitted into their sand paintings flowed out to sick patients during shamanistic ceremonies. Explanations of such art as simply being picture writing, idle doodling, or evidence of hunting magic often miss the crucial point and thus much of the richness of American Indian cultures.

In some regions of the country, investigators have related certain art techniques and motifs to specific Indian cultures and their shamanistic beliefs. The link between the Dakota vision quest and petroglyphs at remote rock outcrops is only one example. The polychrome rock paintings of the Chumash, which have been so extensively analyzed and copied by Campbell Grant, are another.

The Chumash were one of several cultures of southern California and the interior southwest that practiced the tolguacha, or toloache, cult. Toloache, which comes to us via Spanish from the Aztec *toloatzin,* refers to plants of the genus *Datura,* which when eaten produce colorful hallucinations. The plants are also called Jimsonweed, a result of the accidental discovery of their narcotic effects by English soldiers at Jamestown, Virginia. The Chumash thought that the visions produced by the drug foretold the future and made supernatural beings visible. Shamans under its influence thought themselves transported through space and time. It is likely that the colorful and bizarre pictographs were painted during after such experiences.

My own interest in the connecti between rock art and historically d umented shamanism led me to a of petroglyphs on the banks of Kennebec River in Maine. I tau for three years at the University



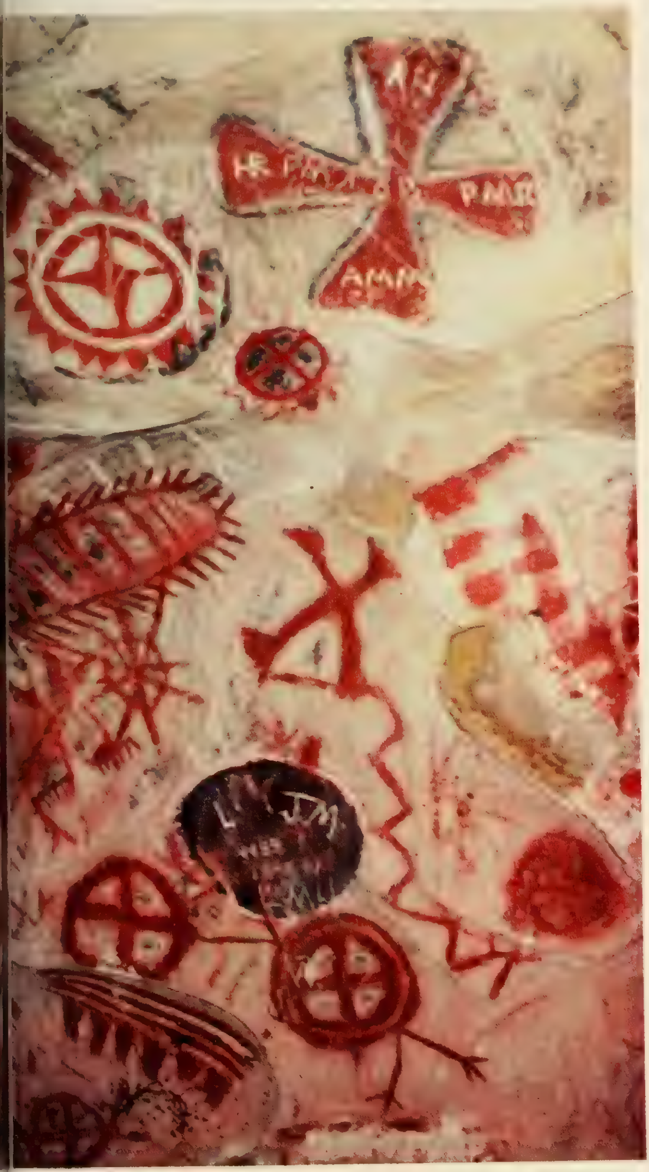
Campbell Grant

aine and during that time became niliar with Abenaki Indian sha- anism and the few examples of rock in the state. The Kennebec is one two primary river courses formerly ed by the Indians of Maine, the her being the Penobscot. The drain- e basins of these two rivers comprised most of the territory of the historic Eastern Abenaki, of which the only remaining resident branch is the modern Penobscot tribe. At one place along the course of the Kennebec through southern Somerset County, a ledge of metamorphosed shale juts out into the current, forming a natural dock for canoes and, as it happens, a smooth surface where the Indians carved petroglyphs. The site is one of only a handful of petroglyph sites in Maine. About ninety distinct figures are visible in a band more than eight yards long and two yards wide. Other figures are too faint to be accurately traced, but the original number may have approached two hundred.

The most striking characteristic of the petroglyphs is their heavy sexual content. The only similar phenomenon occurs at a site near Peterborough, Ontario. Joan and Romas Vastokas of Trent University have studied this site carefully and have come to many of the same conclusions that I reached in my study of the Kennebec petroglyphs. Both sites lie within the general distribution of Algonquian-speaking Indians.

Like the Vastokases, I plunged into the literature of Algonquian shamanism. They found their most solid leads in the writing of Henry Schoolcraft, a nineteenth-century ethnologist. My own search led me to a renewed examination of the writings of Fannie Hardy Eckstorm, a well-known Maine historian, and Frank Speck, an anthropologist who wrote extensively on Algonquian speakers in general and Penobscot shamanism in particular.

I was especially drawn to Eckstorm's biography of John Neptune, an Abenaki shaman who lived from 1764 to 1865. Neptune served as second sagamore (vice-chief) with head sagamore John Attean; together they were the last traditional leaders to enjoy life appointments. Because of Neptune's long life and strong personal charisma, he was remembered by other members of the community long after his death. Both Eckstorm and Speck saw through Neptune's



The complex polychrome paintings of the Chumash Indians of southern California defy precise interpretation. That many of them were hidden in mountain clefts suggests that they were part of a ritual. No longer so isolated, the colorful paintings have inspired modern graffiti.

Algonquian-speaking Indians in Maine probably landed their canoes on this shale shelf of the Kennebec River. The rock's smoothness was ideal for petroglyphs. The sexual content of many of the carvings suggests that shamans made them in an attempt to secure their influence among fellow Indians.

reputation as a rogue, and realized that he was an excellent example of a charismatic leader who was both a shaman and political figure.

The Abenaki called their shaman *medeolinu,* "supernatural man." Such a person was by definition the possessor of a potent magical power whose vagueness heightened its threat, for persons lacking it were never sure who had it or how it might be used against them. Even the shaman himself might not at first be sure that he possessed magical power since its acquisition was involuntary. Unlike the Dakota, the Abenaki usually did not seek out shamanism, but rather accepted it as a fact of life much as one would accept any other idiosyncratic characteristic of personality.

A shaman could cause illness by simply willing it. And he could supposedly cure the illness by ceasing to impose his magical will on the victim. This is not to say that the Abenaki shaman was a curer. Herbal remedies and other practical, nonmagical techniques were normally the province of curers, who did not possess magical powers. A curer had talent, but a shaman had personal charisma, which translated into prestige as well as both real and magical power. The result was that shamans usually rose to positions of leadership in this egalitarian society. In this way, secular power and magical power reinforced and validated each other.

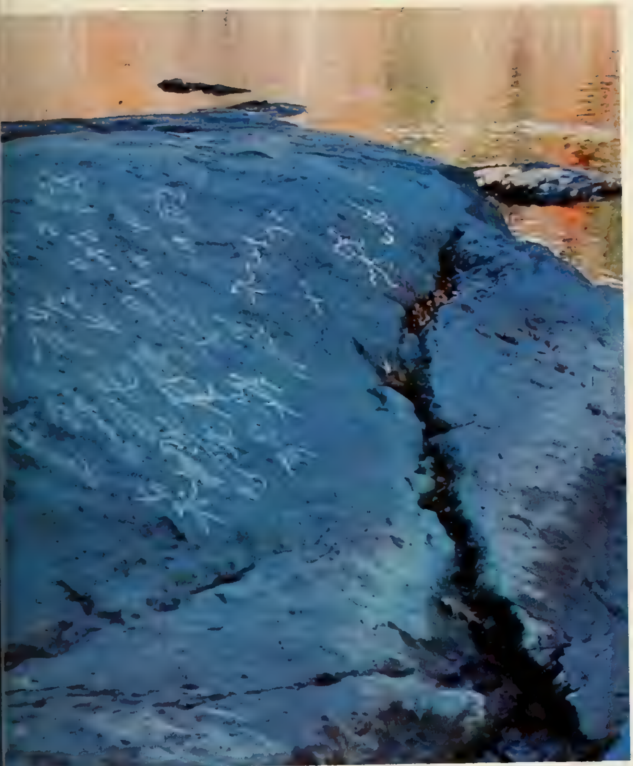
A shaman's sexual prowess was another way in which he expressed his power. Shamans normally had two or more wives and sexual reputations to match. Women occasionally became shamans and acquired the same sort of reputation for magical and sexual power. Because the Abenaki society was normally male dominated, female shamans were generally regarded as even more threatening than their male counterparts. John Neptune had three wives and a reputation as a libertine, the real significance of which we can now readily appreciate, but which escaped most nineteenth-century observers.

Abenaki shamans were quite independent, never coming together into organized societies like Ojibwa shamans. When he wished, a shaman could transform himself into, and travel about in, at least one animal form. To an observer, the shaman's body remained unconscious and inert while this happened. The Abenaki believed that if the animal were killed, the shaman's body died in the same instant. Indeed, this was the logical explanation when a known or suspected shaman died while either sleeping or unconscious.

John Neptune is supposed to have had seven animal forms, the largest number known for any Abenaki shaman. Although his principal form was the eel, he probably treated all seven species with considerable respect. Otters, beavers, porcupines, bears, dogs, and birds served as other typical animals into which shamans could transform themselves. Many legends reinforced this belief; a typical example tells of the hunter who wounded an animal and later encountered a man with an analogous wound. The logical conclusion was that the injured man was actually a shaman in animal form.

A short excursion into Abenaki folklore also supports an interpretation of the Maine petroglyphs. An Abenaki storyteller could shift each of the culture's folk heroes in and out of a cycle of tales in a way confusing to modern readers seeking a clear and permanent structure. Similarly, the Abenaki traditionally believed that a supernatural creature or creatures lived in or on Mount Katahdin, a peak that dominates the interior of Maine. One of the most frequently mentioned creatures was Pamola, often described as a bird with a huge head and wings but without a body. Sometimes this creature was portrayed as being covered with hair or as having a body but no anus; at other times, it was a handsome young man.

In most tales, the characteristics of



Dean R. Snow

the heroes always changed, a frustration to folklorists but not to the Abenaki. The point is that when dealing with the supernatural there was no need for either precision or permanence because the entities described were capable of endless transformation. This characteristic of traditional Abenaki belief makes shambles of modern efforts to impose a rigid structure upon it. Such constant change must be kept in mind in any analysis of petroglyph motifs.

Among the most easily identified Abenaki figures are four human male representations with pronounced phalli. They are also the most obvious evidence of the connections between shamanism, sexuality, and petroglyphs at the site. All four are shown in profile, moving left to right, and three do so with the left arm raised. One figure has an enlarged left hand with fingers splayed, a specific symbol of shamans in Algonquian cultures. The same gesture was common on some historic Ojibwa birchbark scrolls.

Female figures are more difficult to identify because anatomical clues are generally absent. Instead, women appear to be identifiable by posture. Three figures are shown with legs spread and knees drawn up, a gesture of sexual receptivity. Female forms are more often represented as disembodied genitals, possibly an indication that the petroglyphs were made by a man. These occur in two basic forms—one an oval with a short interior line; the other a set of three lines each joined to the others at one end. The latter are common in many North American petroglyph sites, but their frequent identification as bird tracks has tended to obscure their real meaning. Most birds, particularly the birds of prey that most interested North American Indian shamans, have rear toes that leave tracks quite different from the figures here.

Disembodied male genitals are less frequent. There are only two such figures that can be positively identified. Of two phallic representations, one is equipped with wings and resembles bird forms found elsewhere at the site. The connection between birds and sexuality is close. There are at least fifteen birds among the petroglyphs; some of them are almost human in form and at least three are phallic. The bird forms could represent the supernatural Pamola of Mount Katahdin, interchangeably a man or flying creature, a supernatural being or transformed shaman. Whether a phallic bird, a winged phallus, or a transformed human, the representations are a single amorphous concept.

At least thirteen petroglyphs represent canoes, each usually containing two stick figures of humans. Occasionally, one or both are provided with long paddles. One canoe is part of a larger abstract form, another is upside down, and three others are linked together. Still another carries a complex superstructure with what may represent an animal perched on top. Most of the canoes seem to be moving from left to right.

At first glance, the meaning of the petroglyphs appears to be straightforward, even mundane, perhaps the equivalent of Ojibwa water-route markers. But there is no portage or stream fork at this location, nothing that would have required an aboriginal traffic sign. Instead, the canoe motif could represent a deliberate use of canoe transportation as a metaphor for magical transformation. The canoes with their passengers were probably neither less mystical nor less powerful than the other figures.

Of the remaining petroglyphs, some are too abstract or eroded to allow identification; others are too simple to interpret. The simple H form, for example, occurs at least twice here and is also found at sites in Pennsylvania and Ontario, but its meaning remains obscure. Three house forms, whose shapes are consistent with known aboriginal house types, also defy interpretation. There are also animals of unknown species, some of which resemble the "signatures" of Abenaki sagamores on early treaties, possibly the primary forms assumed by these men in their roles as shamans. Despite the remaining difficulties in interpretation, however, the fundamental connection between shamanism and rock art at this site and at many others is strong.

We can only guess at why shamans sometimes chose to express themselves in rock art. The Maine site suggests that unless destruction of rock art sites has been far more severe th
we suspect, this sort of artistic
pression of shamanism was much l
widespread than shamanism its
Perhaps only a few shamans felt
need to fix their power in time a
space by giving it concrete express
in rock art. If so, we can be grate
that these few chose to do so,
without rock art, the varying roles
shamans in the broad range of Ame
can Indian cultures might have l
neglected forever.

Early nineteenth-century Nav
painted these Spanish horsem
below, in Canyon de Che
Arizona. The naturalistic figu
suggest they are not dire
linked to shamanism. Clea
visible only from air, the 1
foot-long effigy, right, scratch
into desert gravel near Blyt
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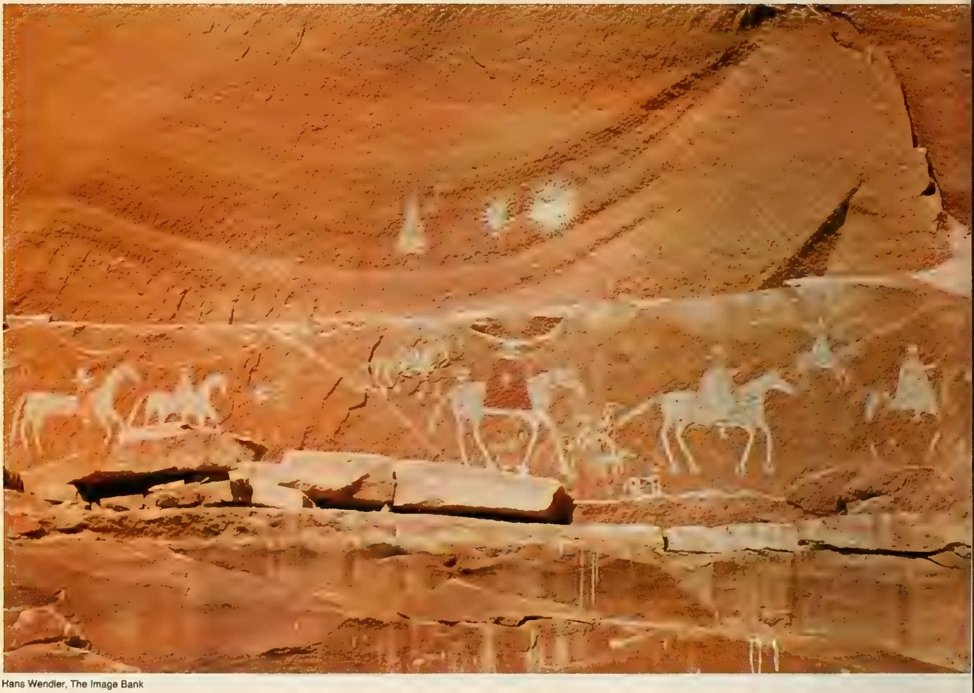

Hans Wendler, The Image Bank

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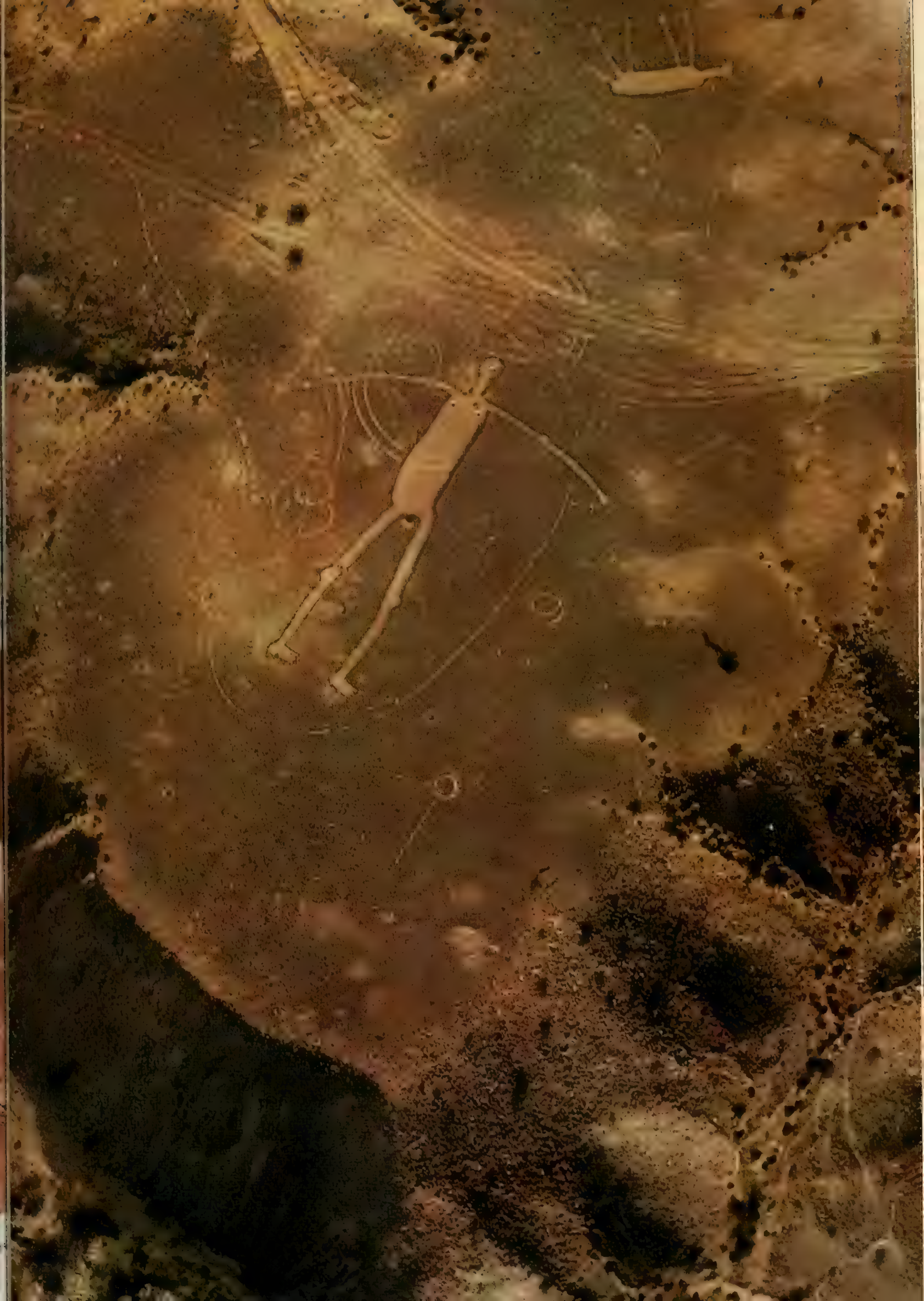


Shotgun Houses

y John Vlach

o obvious in its architecture
s to often go unnoticed,
nis building's evolution
eveals much about those
'ho dwelled in it

Old buildings can tell us a great eal. In many cases, they are the only ecords left of the aspirations and exeriences of those who lived before s. If we care at all about the day-to-ay life of the past in which our resent society began to take shape, e should examine those unpretenous, often derelict structures that sit eside seldom-traveled roads. Should e be sensitive enough to regard nese castoffs as the products of effort nd hope, we might discover a new athway to an understanding of ourelves.

The rich insights that may reward urther searching are illustrated by the tory of a humdrum little house often alled a "shotgun shack." An archiectural saga that began centuries ago n Africa lies enfolded in its shingles nd tar paper. Shotgun houses are ather common in the United States, nd for this reason, do not usually ttract the attention of the passerby. n their most basic form, they are mall, usually rectangular buildings, ne room wide (no more than 12 feet cross); three rooms deep, all conected to each other; and with doors t each end. One supposed reason for heir name is that pellets from a shotun fired through one of the outside oorways could allegedly pass hrough the entire building without oing any damage.

Today, shotgun houses, common in both rural and urban areas, are most often seen in mill towns, cotton and sugar plantations, lumber camps, railroad construction sites, and around oil fields. Traditionally built in this country to house large numbers of workers, they are found from Chicago to the gulf coast and from North Carolina to California.

Their wide distribution during this century makes their history difficult to unravel. Several clues in the American cultural pattern, however, point to Louisiana as the place of origin, in this country, for the shotgun house. Along some stretches of the Mississippi River in Louisiana and in the state's bayou country, no other house form exists. Large numbers of these buildings, many dating back to the last century, are also found in New Orleans, Vicksburg, Memphis, Saint Louis, and Louisville, all river towns first established by settlers as they penetrated the country's interior along its larger waterways.

Architectural historians have thought that the long, narrow form of the New Orleans shotgun house was a reflection of nineteenth-century land pressures, which shaped city lots into narrow, rectangular sections. While it is true that the shotgun plan fit well into the city's urban context, houses of other shapes were also built on these lots. Indeed, the shotgun was not as wide as the usual city lot and was therefore not so restricted by lot size as were some of the large French Creole dwellings. Thus the boundaries set by the city surveyor cannot entirely account for the form of shotgun houses. The proliferation of shotguns in New Orleans suggests an earlier origin based on motivations other than functional ones.

The basic shotgun form is very adaptable. A number of alternate designs in New Orleans suggest that the shotgun house had a long formative period. Such variations were probably a response to conditions not anticipated when the basic shape was first used.

One variant, the double shotgun, developed as early as 1854 and was composed of two single shotgun houses built side-by-side under one roof. Builders also expanded shotgun houses vertically to create "camelback" or "humpback" houses. In these buildings the last rooms were two stories high, thus producing a hump. The double shotgun was also modified by the creation of a second-story rear addition. The development of porches produced yet another variation. Dwellings known as "north shore" houses had wide verandas on three sides. Most of these were built in the piney woods region along the north shore of Lake Pontchartrain, where many wealthy white residents of New Orleans spent the summer months.

Shotguns of this latter type were built in New Orleans as early as 1832. In addition to early dates of construction, variations on the basic shotgun design also suggest antiquity by the very fact of their existence. The long history of the double shotgun, the single and double camelbacks, and the north shore houses provides strong evidence for assum-

Louis Street, New Orleans

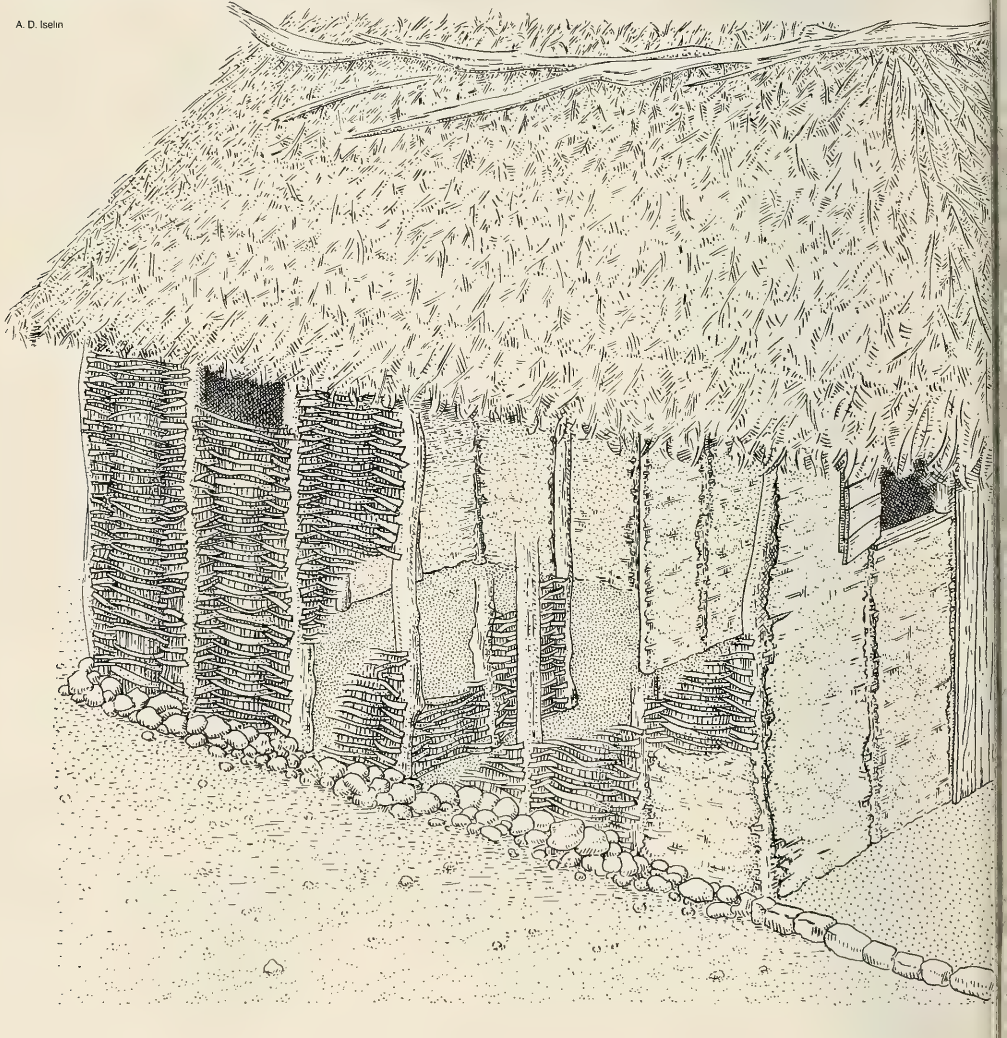
'nor

ing that the basic single shotgun originated in the first quarter of the nineteenth century. Sporadic documents provide evidence that shotgun houses were sold in the 1830s. These houses were probably built at least fifteen or twenty years earlier.

The origin of the shotgun house lies in the history of New Orleans's black community. In 1803 there were 1,355 free blacks in the city, many of whom were active and successful in a variety of trades. The size of the community was greatly increased in 1809 by the immigration of approximately 2,100 Haitian mulattoes, who first emigrated to Cuba but were later forced off the island by anti-French sentiment. At the same time, a like number of slaves arrived from Haiti, including many who were relatives of free blacks. By 1810, blacks outnumbered whites in New Orleans, 10,500 to 4,500. Such a population expansion necessitated new housing. As many of the carpenters, masons, and inhabitants were Haitian, it was only natural that they modeled their new homes on those they had left behind.

Even today, many Haitian dwellings closely resemble the single shotgun houses of New Orleans; in some cases, they are identical. More ir
portantly, they share the same set
secondary characteristics. Roo
sizes are comparable: dimensio
average 12 by 14 feet in New Orlea
and 12 by 12 feet in Port-au-Princ
the capital of Haiti. Ceiling heigh
are about 12 feet in both cities. Pa
terns of internal partitioning are al
shared. The first two rooms may b
converted into, or treated as, o
large room. House façades in Po
au-Prince and New Orleans fr
quently have two tall frontal opening
that serve as either doors or window
Furthermore, shotgun houses in bo

A. D. Iselin



es carry a large amount of decora-
n on their fronts, while the sides
neglected.

In Port-au-Prince, shotgun houses
re an alternative to Creole houses.
is latter type of building was based
Norman houses and was used pri-
rily by French colonials. Although
re are some similarities in plan to
reole house type, the shotgun ap-
ars to have developed inde-
ndently, occurring in those areas
it were formerly under the exclu-
e control of the free blacks. Conse-
ently the shotgun house is most fre-
ent in southern Haiti near Port-au-Prince and rarely appears in the north, the area dominated by the former colonial capital, Cap-Français (now Cap-Haïtien).

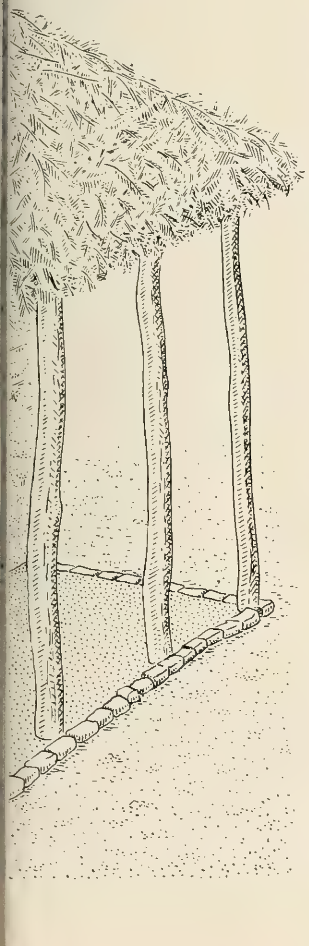
The long association of free Haitian blacks with the shotgun house type is suggested by the way in which they clung to the design in the late nineteenth century. Even when the Neo-Gothic style—with its spires and lacy trim—was brought to Port-au-Prince from Europe, the narrow shotgun house design was retained as the core of the new architecture, with the new elements draped over the outside of the older form. This tenacious conservatism indicates that Haitian blacks had become accustomed to the shotgun form, retaining internal familiarity while bowing to stylish fashion.

The shotgun houses of Port-au-Prince, however, have as a local antecedent the dwellings constructed by slaves brought from Africa to Haiti in the early eighteenth century when a strong plantation economy began to develop.

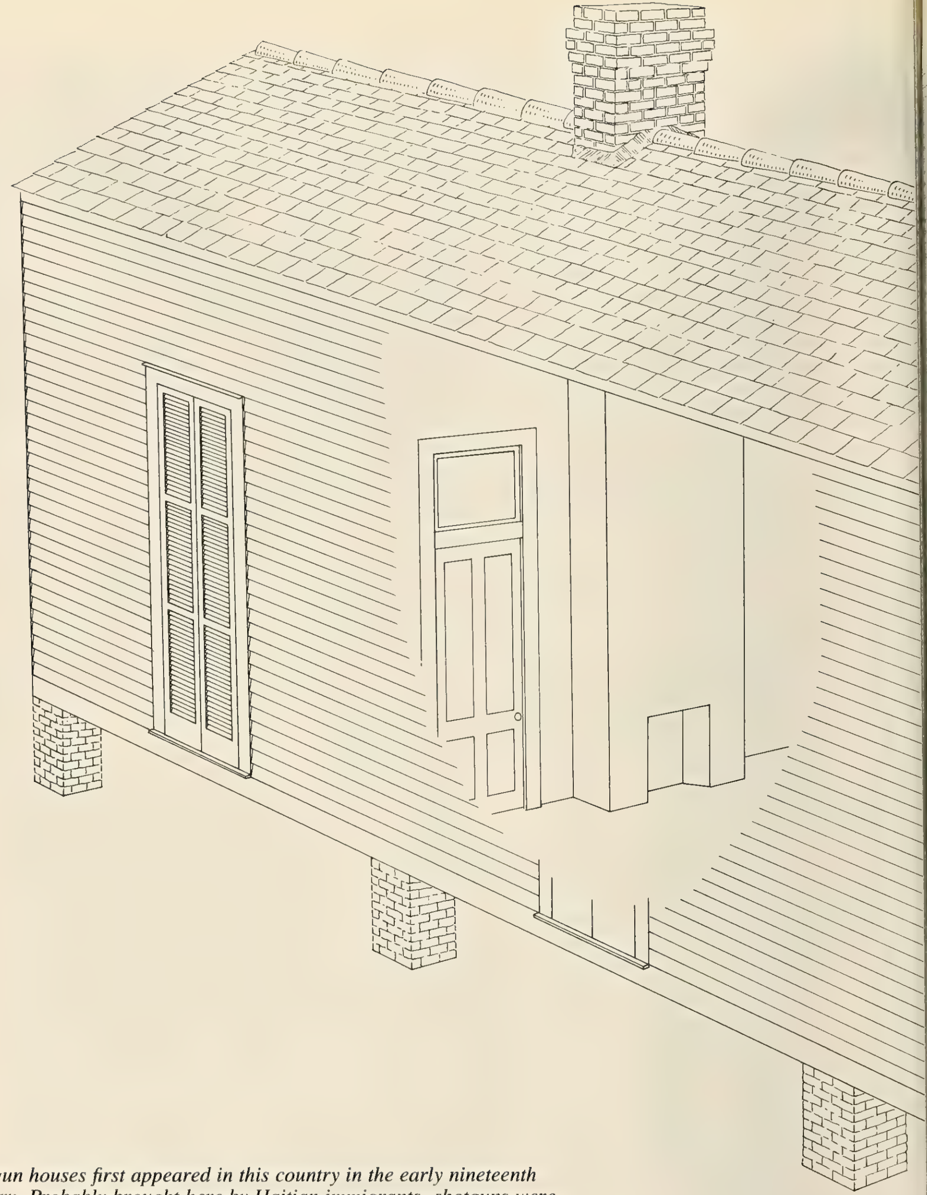
The architectural style of plantation housing in Haiti developed from the interaction of the indigenous Arawak Indians, the French colonials, and the slaves. The Arawaks lived in both round and rectangular houses. The rectangular type, called a *bohio,* was very much like the shotgun in form, but was significantly different in that it had only one room. In the seventeenth century, French settlers copied this building for their own dwellings. The first Frenchmen in Haiti were groups of vagabonds who for almost a century lived a hunting-and-gathering existence while plundering and raiding the sea lanes of the Caribbean. They had no need for a more substantial house form than the *bohio;* thus it remained a familiar dwelling long after the settlers had killed off the Arawaks.

When the slaves built their plantation dwellings, they used the form of the *bohio,* but made it a two-room structure. These houses, constructed of wattle and daub with thatched roofs, were one story high, one room wide, and two rooms deep, had a frontward-facing gable, and usually measured 10 by 20 feet. Today, parts of the southern Haitian countryside are dotted with similar buildings. The stable size of these rural dwellings represents more than two centuries of building custom. Urban shotguns and their rural prototypes can thus be linked in a continuum since they are of the same type. But for the origins of this house form, which evolved after the eighteenth-century influx of slaves, we must look to west Africa.

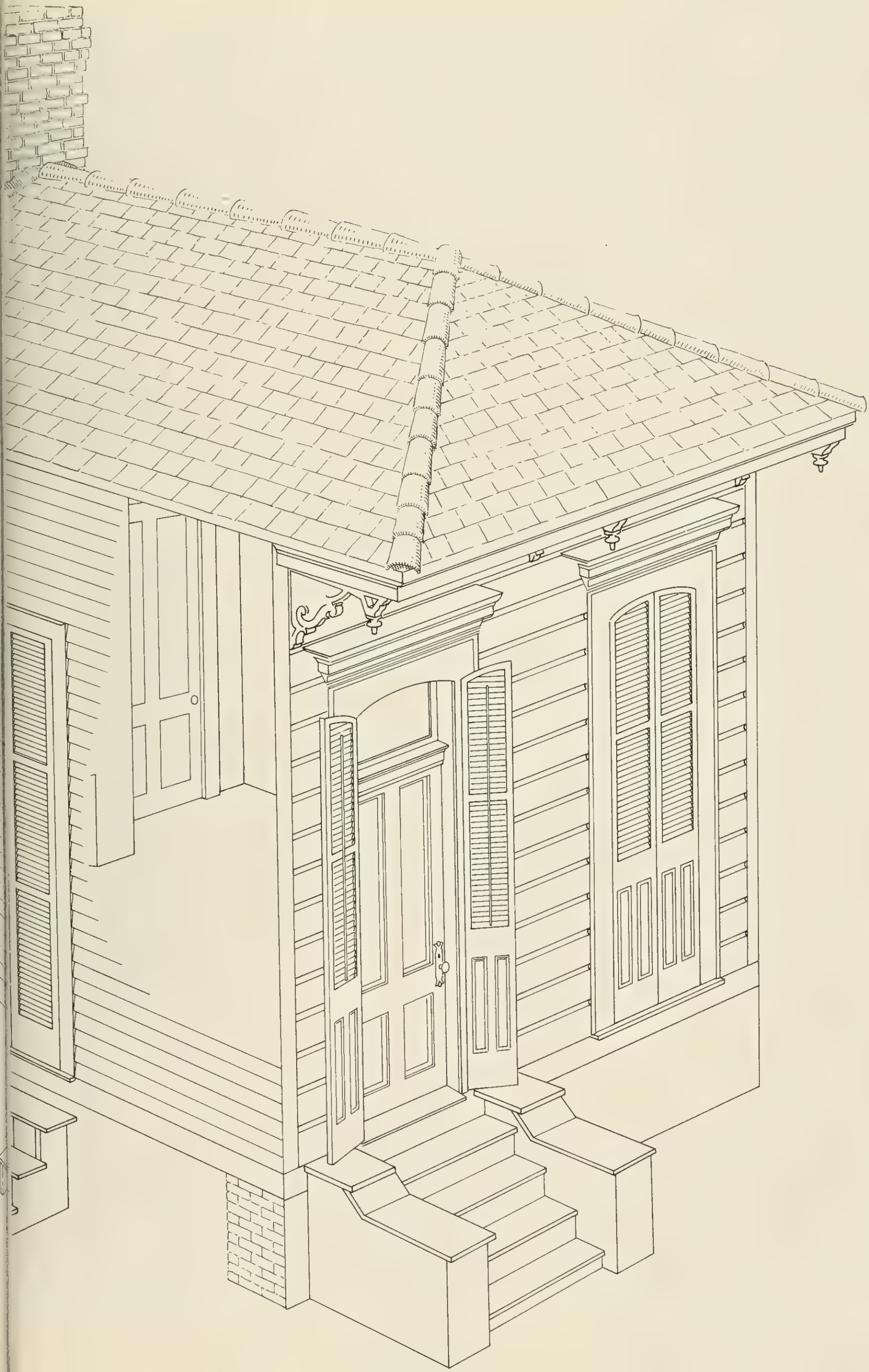
During the entire slave period, many of the Africans who were taken to Haiti came from southwestern Nigeria, an area dominated by the Yoruba. The houses of the Yoruba, like those in most of western and central Africa, are extremely similar, in spatial terms, to rural shotguns in Haiti. The basic Yoruba house is a two-room module measuring 10 by 20 feet. This unit is variable in its orientation; either the long side or the gable may face the front. With the doorway on the gable end, the house is a true shotgun. The Yoruba slaves probably continued to use their customary buildings after they arrived in Haiti; they had only to make a minor



The south Haitian countryside is dotted with these wattle-and-daub shotgun houses almost identical to the slave quarters of mid-eighteenth-century plantations. Occupied by a single family, the rear room is usually used for sleeping; the front room for storage and cooking. Construction materials—crushed sugarcane stalks for the roofing, split laths or small saplings for the wattle, and mud and clay for the daub—are salvaged from any available sources. Other materials, such as nails, screening, and whitewash for the walls, cost about $50, a high price for many peasants.



Shotgun houses first appeared in this country in the early nineteenth century. Probably brought here by Haitian immigrants, shotguns were inexpensive to build and could quickly provide housing for large numbers of people. Now of several types, the basic structure for all shotguns is exemplified by this single shotgun. The size of each building is similar—three or four rooms deep, each room measuring twelve by fourteen feet. Most shotguns in this country have some adornment under the overhanging eaves; the front of the house being the only part visible from the street. Formerly, shotguns may have had two front doors. Now, virtually all of them have one door at the front and one at the back, leading to a yard that once served as an outdoor kitchen.



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adjustment to preserve their preferred house form and simultaneously satisfy the demands of plantation owners. Furthermore, the similarity between Yoruba houses and other houses in western Africa allowed other African peoples to accept the Haitian shotgun as their own.

The two-room dwelling is the core of many Yoruba houses, and the continuous use of the 10- by 20-foot unit suggests that it is a basic premise of design in Yoruba architectural traditions. Entire compounds are fashioned by grouping two-room units together. The compound, the domain of the extended family, is a large rambling structure with many rooms arranged around an open courtyard or a small impluvium.

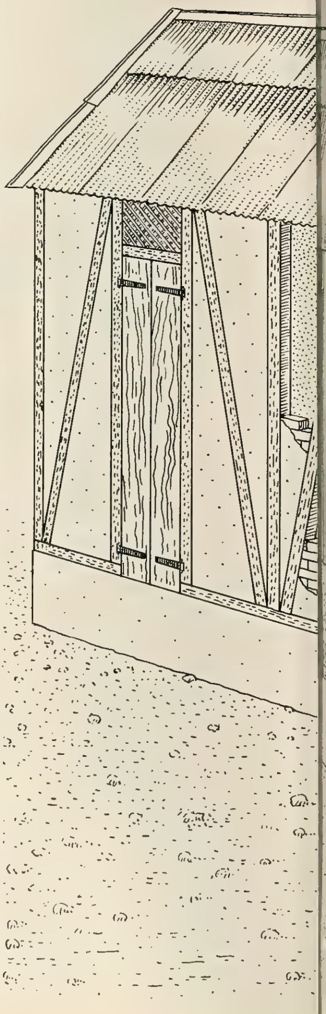
Compounds are called *agbo ile* in Yoruba, literally "a flock of houses." This term suggests something of the process by which these houses evolved. Compounds, some of which are said to be more than 300 years old, are the conglomerate result of individual family segments building all their dwellings in one place, using the same kinds of housing units they would have built separately, but in this case, constructing the units in accordance with a communal living pattern.

The odyssey of the shotgun house from Africa to the United States is long and complex. African architectural concepts provided the central, formative influence for plantation houses in Haiti. These concepts, together with features borrowed from house forms used by Indians and Europeans, were incorporated into the rural Haitian shotgun. The long association of blacks with the house form was not severed when slaves were granted their freedom. The mulatto class took the mud-and-thatch house and, by changing the techniques of construction, transformed it into a stylish city dwelling. But their changes did not alter the plan of the building. The internal pattern remained familiar. The shotgun form became for the free Haitian black a physical symbol of independence. And when Haitian blacks were forced to migrate to New Orleans, they retained the basic form.

The importance of the odyssey from the Caribbean and western Africa lies in the African influence that the shotgun house displays in this country. Here, the shotgun is common in black areas and hence is Afro-American by virtue of its users. But in some regions, like Bayou Lafourche in Louisiana, it is the dominant house type used by whites. Although there may be two shotgun traditions—one black and one white (in the latter, the buildings are wider)—both are clearly derived from a single house form.

Although the term shotgun may be related to the door arrangement of the houses and the idea that shotgun pellets fired through the house will meet no obstruction, the name may have also originated from western African languages. Several words commonly used in New Orleans came from western Africa. *Voodoo*, derived from the Fon word for the god Vodun, is a prominent one. In southern Dahomey, the Fon area, the term used to describe houses is *to-gun*, "place of assembly." The description, probably used in New Orleans by Afro Haitian slaves, was misunderstoo and then reinterpreted as shotgun.

But what significance could thi house type have for the black community? We are only now beginning t understand that humankind possesse an internal architecture of ideas, tha we have architecture without buildings. With space as our only medium we are constantly constructing invisible barriers, walls, and fences behind which we conduct our daily rituals of conversation, greeting, intimacy, and personal encounter. In black neighborhoods there is often a

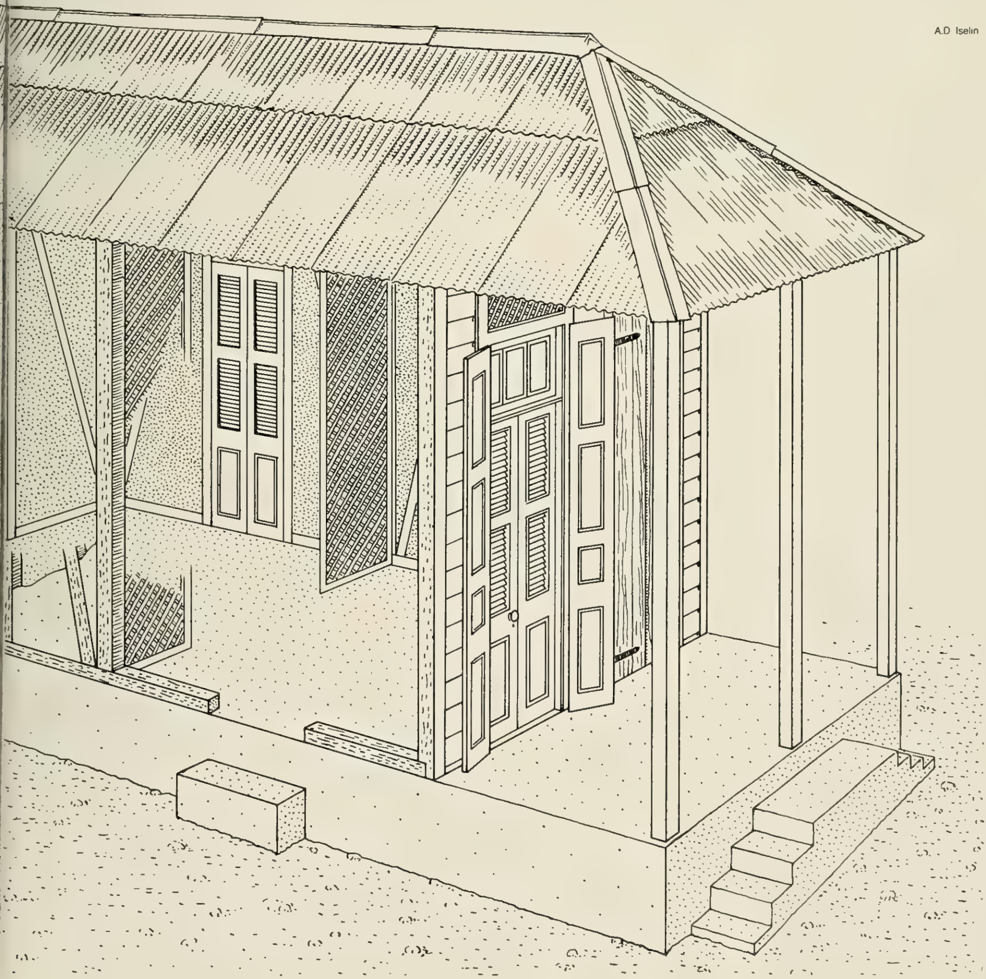


About 15 percent of the housing in Port-au-Prince, the capital of Haiti, consists of this type of shotgun house, although none have been constructed since the 1900s. Formerly occupied by single families, the severe housing shortage in the city has resulted in many shotguns becoming multiple dwellings. Although this cutaway shows an interior wall of brick, the walls of many such buildings were usually constructed of rubble. Tin roofs were introduced in the latter part of the nineteenth century by French colonialists.

eat degree of tactility in the way
ople interact. Touching—hands on
oulders, slapping of knees, exten-
ve ritualized handshakes—is com-
on. There is a type of physical inti-
acy that is measurably absent in the
ce-to-face encounters in many
hite communities.

A tradition for this physical close-
ss is implicit in the shotgun house
an. The series of small rooms, usu-
ly joined without hallways, forces
mily members in one of two direc-
ons—into contact with each other or
it to the porch and street. When
any shotguns are put side by side, as in a plantation arrangement or a city block, interaction with neighbors is as frequent as involvement with one's family. I once asked a group of black women in New Orleans to define a shotgun house. Their collective reply was, "A shotgun house is a house without privacy." But in positive terms, it is a house in which there is a focus on communal activity; it is an architecture of intimacy.

This attitude has its counterpart in western Africa where the communal compound is generally dominant. The many rooms of this building type provide a spatial realm in which a hundred or more family members can interact communally or where small segments of the family can be together. In this way priorities for public and private intimacy are satisfied. While the shotgun house differs greatly in form from a Yoruba compound, in philosophy, a neighborhood of shotgun houses is identical to a compound. The shotgun house thus serves today as a vessel in which an alternative black tradition, an etiquette of involvement, has been maintained. The shotgun house is a physical expression of an Afro-American state of mind. ☐


A.D Iselin

A Coarrangement of Kingfishers

Photographs by Mila Olano and Javier Echevarri

Playing the mating game on the banks of a Spanish river

Along the shores of the world's fresh waters, there is an ecological niche for an avian predator of small fish and other aquatic organisms. A small bird, with a strong, compact body, short neck, large head, and long, pointed beak, the European kingfisher (*Alcedo atthis*), fills this niche along many of the slow-flowing streams and rivers, canals, ponds, lakes, and marshes of northwest Africa and the greater part of Eurasia—from northern Europe to central Russia, south to India and southeastern Asia, and eastward through Indonesia to New Guinea and the Solomon Islands.

The bird is an excellent fisher, capturing its aquatic prey by making quick plunges into the water from observation perches, such as branches and roots, overhanging a stream. At times, a European kingfisher will hover over the water almost vertically and plunge from that position.

Fish make up approximately two-thirds of the kingfisher's diet; aquatic insects another sixth. Favored prey species are minnows, sticklebacks, and gudgeon; small trout, stone loach, and roaches are other fish often taken. Other prey items include water beetles, Odonata larvae, hemipterons, small mollusks, frogs, tadpoles, and worms. Most of the fish taken are of populous, smaller species. A culling effect results from kingfisher predation because aged, diseased, and weaker fish are more easily captured.

The European kingfisher is not a sociable species, but during the breeding season from March to August, prospective mates seek each other out, form a pair bond, build a nest, and raise young. The male delivers a courting song, often while in a butterflylike flight. When a female responds, an aerial chase ensues, the pair often rising to considerable heights. As part of his courtship flight, the male zooms about in circles and figures of eight. The female responds to the courting, and as the bond between them becomes firmer, there is much bowing and bobbing by both sexes. Sometimes the male will stroke his mate with his bill; usually he will feed her a fish. Copulation often follows such ritual feeding.

A spot in the earthen bank of a stream or river is selected, and the mated pair begin nest construction. Both birds vigorously hammer at the embankment that will house their nest burrow, knocking out small clumps of dirt with their beaks. After about a day, the female is able to cling to the edge of the hole she and her mate have made. Tunneling begins as she pecks away at the earth, enlarging the hole and deepening it to a length of one and a half to three feet. The male participates in the construction effort by using his feet to shovel out the dirt loosened by the female. The three front toes in this species are fused for more than a third of their length, enlarging the sole of the foot. This is an important adaptation for such burrow nesters, enabling the birds to scoop soil from their excavations by pushing it backward with their feet.

An area roughly 130 meters (426 feet) upstream and downstream from the burrow is claimed by the pair as a nesting territory. During this period of nest-site defense, the female seldom ventures farther than nine meters (thirty feet) from the burrow entrance. By keeping other kingfishers out of the immediate area, the mated pair reduce the predation pressure on the local fish population upon which they depend heavily during the periods of egg laying, incubation, and rearing of their young.

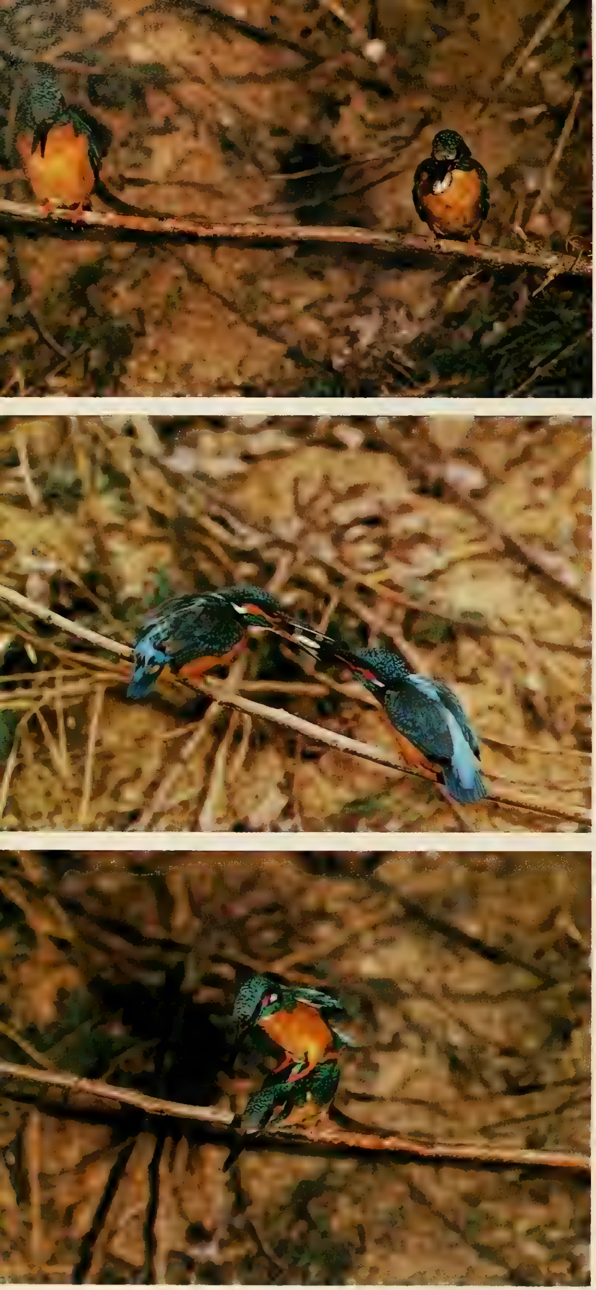
Copulation is frequent from the time the burrow is completed to when the first eggs are laid—a period of about ten days. Up to four matings a day, usually between four in the afternoon and half-past eight in the ev ning, have been observed. Typicall six to eight white eggs are laid durin the middle of April and hatch at th end of the first week in May in th southern part of the species' range.

After she has incubated the egg the female assumes the greater r sponsibility for feeding the youn The male helps with some of the fee ing but usually drops out at an ear stage. When either adult enters th passage to the nest, located at the te minus of the slightly upsloping bu row, most of the light is blocked ou This darkening of the burrow trigge a behavior in the young nearest th passage entrance: it opens its bill be fed. After receiving a morsel food, this nestling moves so that th next in line has a position near th passage opening. The procedure repeated until all the young are fed

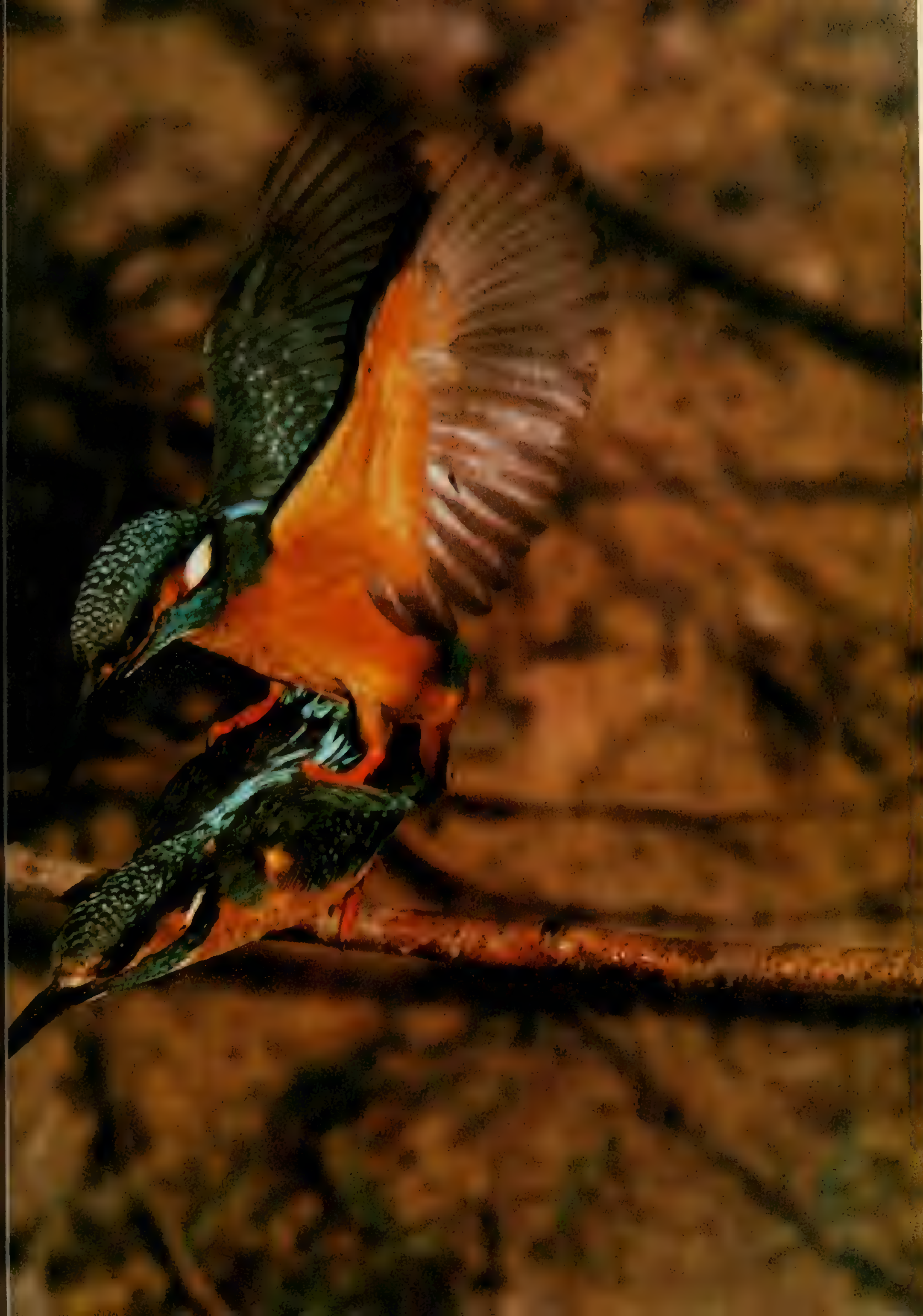
The young disperse from the ne area only a few days after fledgin and soon become as intolerant of on another as the adults are outside of th breeding period. The parents separa soon thereafter as well. Since kin fishers periodically suffer heavy mo tality during severe winters, a di persal mechanism based on social in tolerance aids in the recolonization depleted areas. Kingfishers ofte breed twice in a season; this, togethe with their large clutch size, help them recoup population losses. The fecundity and their adaptations f feeding on fish have enabled kin fishers to occupy the niche of avia predator along the shores of so man bodies of fresh water.

Frederick Hartman

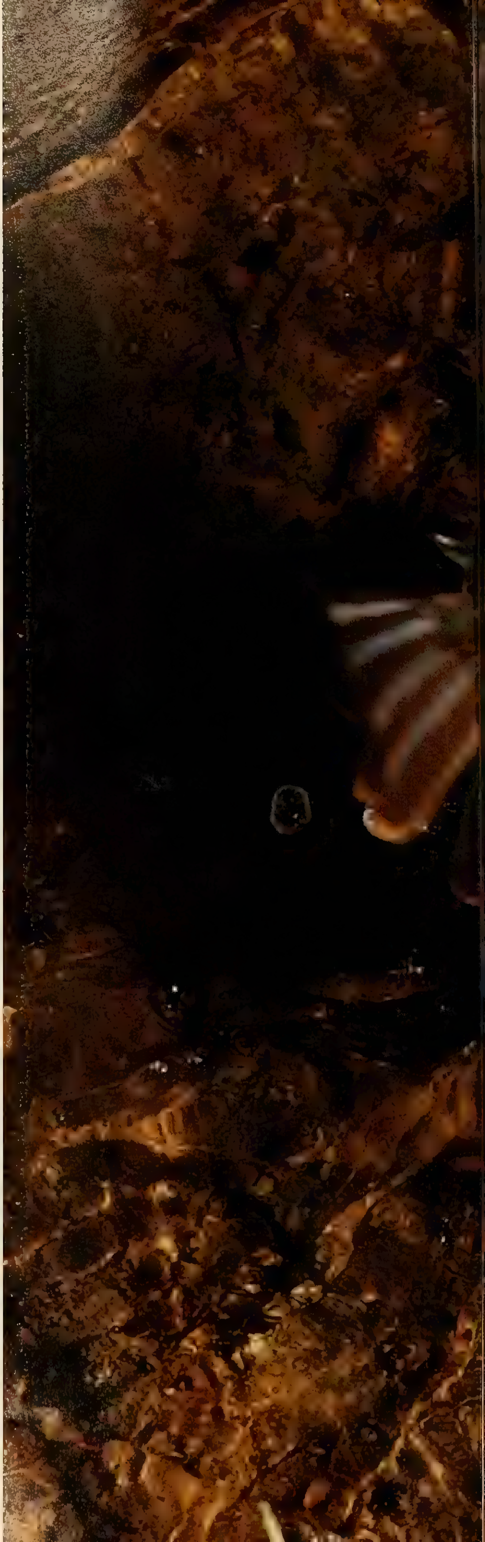
Singing from a perch alongsid the Río Trabancos in Spain a European kingfisher advertise for a mate. Both sexes sin during the premating seaso



As a prelude to copulation, a male kingfisher, carrying a small fish he has just caught, joins his mate on a favored perch. He presents the fish, head first, to the female, and as soon as she has swallowed it, he mounts her.



Scanning the water below, a kingfisher spots its prey. With a rapid plunge, the bird smacks into the water and catches a fish. Meal in beak, right, the successful fisher rises to begin the flight back to the nest burrow.



Endangered Fish of Kentucky Streams

by Branley Allan Branson

While some highly visible endangered species are receiving the support of conservation efforts, many smaller ones are on the verge of extinction

The last two decades of American history have witnessed the emergence of an environmental awareness whose momentum has at times been retarded by its development of a blind side. While environmentalists focus on highly visible animal species such as the timber wolf and sandhill crane, the habitats of three-inch minnows and perches are being progressively fractionated. A concern with the
ture ecological requirements of ma
of the small aquatic organisms n
under siege may be only academ
unless we develop a comprehensi
environmental ethic to protect th
present habitats.

Aquatic ecologists and ichthyo
gists generally agree that the rec
economic recession and energy cri

Russe Kinne, Photo Researchers

ouraged the relaxation or virtual
ination of environmental stand-
that were achieved only with ex-
ne difficulty in the first place.
v, water-quality standards are
n ignored to permit coal mining
oil drilling, and laws stipulating
eclamation of land stripped for its
are not always enforced. The lat-
s a form of environmental degradation that goes far beyond the obvious.

Nowhere has the impact of coal removal been more apparent than in the Appalachians. Yet there are segments of Appalachian forests that have escaped such human molestation. One of these is Kentucky's Daniel Boone National Forest.

At first glance, this forest appears

Restricted to the larger streams of Daniel Boone National Forest because of its size, the paddlefish's future is threatened by the construction of dams that prevent upstream migration for spawning.

One of several ancient species, the bowfin, right, inhabits sluggish, but clear, streams. This narrow ecological niche makes the species especially vulnerable to man's alterations. Another relict species, the rosyside dace, below, develops brilliant hues in April just before mating. During the rest of the year, it is a silvery gray color.

Tom McHugh, Photo Researchers

Robert St

e an artificially delineated area en- ed by political boundaries, but er scrutiny reveals that its borders ow the region's geography. ınd on the east by uplands and the ient Teays River system, on the h by the Ohio River and the gla- ed flatlands beyond, on the south the wide valley of the Tennessee er and the Appalachian Moun- s, and on the west by the Missis- ɔian Plateau, the forest encom- ses more than 627,000 acres. re, sandstone cliffs, natural lges, stone arches, and waterfalls scattered throughout a deciduous st rich in woody plants (more than species), herbaceous flowering ıts, and nonvascular species like ıs and mosses. Many of the small leys support magnificent eastern nlocks, tulip poplars, native pines, l dense stands of rhododendron, untain laurel, and holly.

Although the forest sometimes gs to the gobble of wild turkeys l the gnash of beaver teeth, most he large game and fur-bearing ani- ls quickly vanished following the val of white settlers. Until recent ırs, however, the native fish fauna the forest remained nearly intact, ncipally because of the wealth of ar-water habitats and sparse man activity.

Now, populations of these fish spe- s are being threatened. One, the elip sucker, is thought to be ex- ct. Others, ranging from the large l primitive paddlefish (*Polyodon athula*) to the minnow-sized peye shiner (*Notropis ariommus*) becoming increasingly rare as n's encroachments outside the est steadily wear away the stability the forest itself.

Three major rivers traverse the est, and their tributaries exten- ely interlace the uplands, running ough corridors of nearly impene- ble growths of rhododendron. The torically important Cumberland ver is the most beautiful of the three ers. Together with its main tribu- ies, the Big South Fork and the ckcastle River, the Cumberland ains the entire southern portion of forest—more than 5,000 square les.

Almost 7,000 square miles are ained by the Kentucky River. Since heads in the eastern coal fields, the Kentucky has been severely affected by strip mining. In addition, the river's lower portions were modified by a series of navigation locks and dams constructed from the mid-1800s to 1917.

The Licking River, encompassing 3,700 square miles of drainage, is the smallest of the three rivers. Some of the highest-quality streams in the state, however, drain into this river from the northern portions of the forest.

Until the end of World War II, these three rivers and their tributaries were refuges for nearly 150 fish species that were steadily being decimated elsewhere because of habitat degradation. Lacking modern highways and large population centers, the interior of the Kentucky highlands was practically isolated from the crunch of modern civilization. With the dawn of the 1950s, increased demands for energy-rich coal and rapid transportation ended this protective isolation for more than a score of sensitive fishes.

Only two fish species indigenous to the waters of Daniel Boone National Forest, the harelip sucker (already extinct there) and the lake sturgeon, are listed in the International Union for the Conservation of Nature and Natural Resources' *Red Data Book* of threatened and endangered species. This listing, however, includes species from every part of the world and has little relevance when considering localized populations of fauna. A species facing extinction in one part of its total range may exist elsewhere in large numbers. In Boone National Forest, twenty-three fish species are suffering from varying degrees of habitat deterioration. Not all of these species exist in safe numbers elsewhere. This type of degradation is by no means restricted to the Appalachians. Practically every state lists one to twenty or more fish species as rare, threatened, or endangered by human activities. A wide range of these activities affects the fish species of Daniel Boone Forest.

Highway construction is one of the most underestimated sources of water pollution in America. Single-lane roadbed preparation can stimulate the production of nearly 4,000 tons of silt per mile of construction, and the amount produced by highways is at least twice as great, depending on slope and terrain. The silt eliminates fish faunas by smothering eggs and fry, by destroying food chains, and by interfering with photosynthesis and reproduction.

During the last ten years, the construction of Interstate 75 and two turnpikes has severely damaged Daniel Boone Forest's waters. Highway construction disturbance along the upper Cumberland, several large creeks in the Licking River drainage, and three major tributaries of the Kentucky River is delivering serious amounts of silt to those bodies of water. One fork of the Cumberland is virtually blocked by great piles of mud and debris. Little effort is being made to curtail this type of pollution anywhere in the United States.

Acid-water pollution is another effect of highway construction. Sulfide-rich rocks are a common feature throughout this country's mountainous regions. When construction disturbances uncover these rocks (they are also used as fill materials), pyrites are leached into streams where they increase the acidity of the water. As a result, annual fish growth is retarded, mortality increased, and reproductive ability curtailed by as much as 50 percent. This type of disturbance also often increases concentrations of metal ions in the water—particularly zinc and aluminum—which may kill fish by inducing gill hyperplasia.

But highway construction is just one, underpublicized threat to stream fishes in Appalachia and other parts of the country. Bank clearing, to hasten runoff and as a preliminary step in channel straightening, causes serious erosion and associated siltation in some 25 percent of the Cumberland River system and perhaps as much as 30 percent of the Kentucky system. Channel straightening, particularly in the Kentucky River basin, aggravates bank erosion, and clear-cutting of timber above streams adds still more silt.

The causes of stream degradation are not always so obvious, however. A very innocuous type of influence, one that we have allowed to creep across the nation's waterways practically unchallenged from the 1940s until recent years, is the construction of large dams. Seven dams block the drainage system in Daniel Boone National Forest—two on the Licking, three on the Kentucky, and two on Cumberland streams. A dam can completely eliminate a shallow-water species; the recent, nationally publicized plight of the rare snail darter in Tennessee is but one example. Its influence, however, stretches far beyond its immediate construction site. During dam construction, a stream must be diverted until the dam is completed. This usually results in heavy downstream silting. Further downstream changes, often involving displacement of 50 percent or more of the fish species in the stream, occur after completion of a dam. As a reservoir builds up behind a dam, cold water from its depths enters the stream, lowering the temperature to such an extent that warm-water fish cannot survive or reproduce.

Many dams completely block passage of seasonally migratory fish, such as suckers, native lampreys, and white bass, to their spawning grounds. According to a Kentucky Fish and Wildlife Resources Commission report, the future of muskellunge in the Middle Fork of the Kentucky River is precarious because the Buckhorn Reservoir dam prevents spawning.

Not only do dams prevent passage of the primitive paddlefish (*Polyodon spathula*) to upstream spawning grounds but their presence often disrupts the essential spawning stimulus. The paddlefish, so named because of its elongated, flattened snout, often attains a length of five feet or more, spends most of the year in deep, downstream pools of water, and makes spawning runs upstream only when heavy spring rains cause a rapid rise in stream levels. Dams tend to prevent flood stages and hence spawning.

Siltation of spawning beds also eliminates paddlefish. These factors have, at the same time, been instrumental in exterminating the lake sturgeon and the shovelnose sturgeon, neither of which have been seen in Daniel Boone National Forest waters for many years. The harelip sucker has also suffered the same fate.

The effects of surface mining far exceed the combined damage of all other stream-degrading factors in the Appalachians. Like highway construction, strip mining results in acidification and siltation of streams and rivers. In the process of stripping overburden from coal seams, sulfide-bearing rocks exposed to air and water produce hydrosulfuric acid, which flows into streams and increases their acidity. The effect on the gills and blood of fish often results in the complete eradication of faunas. Such has been the case in the Beaver, Stinking, and Straight creeks of the Cumberland River system and in Goose Creek, a tributary of the Kentucky. In addition, acidic drainage enters practically every stream in Bell and Harlan counties, and more than half of those in five additional counties drained by the Cumberland River, as well as 1,000 miles of streams in the upper Kentucky River drainage.

The real culprit of surface mining, however, is the silt from eroding spoil banks, haul roads, active mining sites, and coal washers. Silt load in streams sometimes increases thirty times the normal amount. Its effect upon fishes is just as drastic as acid mine wastes, although the process takes longer. According to our research, more than 200 miles of streams in the Licking River drainage system, 850 miles in the Kentucky River system, and almost as many in the Cumberland River system are afflicted by mine-derived silt.

There are approximately ten million acres of unmined coal in eastern Kentucky. And in all of Appalachia more than thirty million acres of coal fields have not yet been stripped. When we project the known devastation to these as yet unmined areas, the magnitude of the problem facing small-stream fishes begins to emerge more clearly. Few people are aware of the problem; fewer still seem to care. I was particularly chagrined to receive a letter from the pro-coal editor of a magazine who wrote, "Since these fishes have no commercial value, 95 percent of the public couldn't care less what happens to them." Most Americans are unfamiliar with the presumed extinction of the harelip sucker but even small schoolchildren recall the sorry fate of the passenger pigeon.

The twenty-three rare, threatened, and endangered fish species in the forest's drainages system can be divided into three categories: relict sp
cies from the past, species with sp
cialized habitats, and species w
specialized feeding and breedi
habits. The first category includes t
paddlefish, sturgeons, and the bow
(*Amia calva*). All of them have e
tremely long genealogies and
quired millions of years to adapt
their present environment. These fi
apparently have been able to compe
with more modern fish, but their to
erance for man's activities is ve
low. The bowfin is not endanger
throughout its entire range, but a
propriate habitats for this large pred
ceous species in the forest are scar
and only minimal damage could
minish its populations.

North America is rich in fish th
live in widely separated relict popul
tions where the habitat has remain
unchanged for many hundreds
years. These fish have narrow habi
requirements, such as small sprin
and clean, sandy bottoms. Dani
Boone Forest has some of thes
niches. The rosyside dace (*Clin*
stomus funduloides), silvery minno
(*Hybognathus nuchalis*), and th
speckled chub (*Hybopsis aestivali*
are relicts in forest streams, but all
them are threatened by increasing si
and acid mine drainage. The popey
shiner (*Notropis ariommus*) is a ra
species throughout much of its range
including segments of the upper Ke
tucky and Cumberland drainages
the forest, where mining operatio
threaten the fish in all its known popu
lation sites. This handsome minno
has completely disappeared from tw
large Kentucky River tributaries–
Red Bird River and South Fork—an
its populations are seriously deplete
elsewhere.

Twelve perch species in the fore
are endangered. More than a hundre
species of these highly colorfu
three- to six-inch-long fish—calle
darters—exist in this country bu
most Americans are not even awa
of them. Such little-known animal
need the greatest safeguards, for the
can become extinct without anyon
ever noticing.

Darters are a very specialize
group of fishes requiring particula
habitats. They do not have air blad
ders, so they are restricted to livin
on, and feeding from, the bottom o
relatively shallow, well-aerate

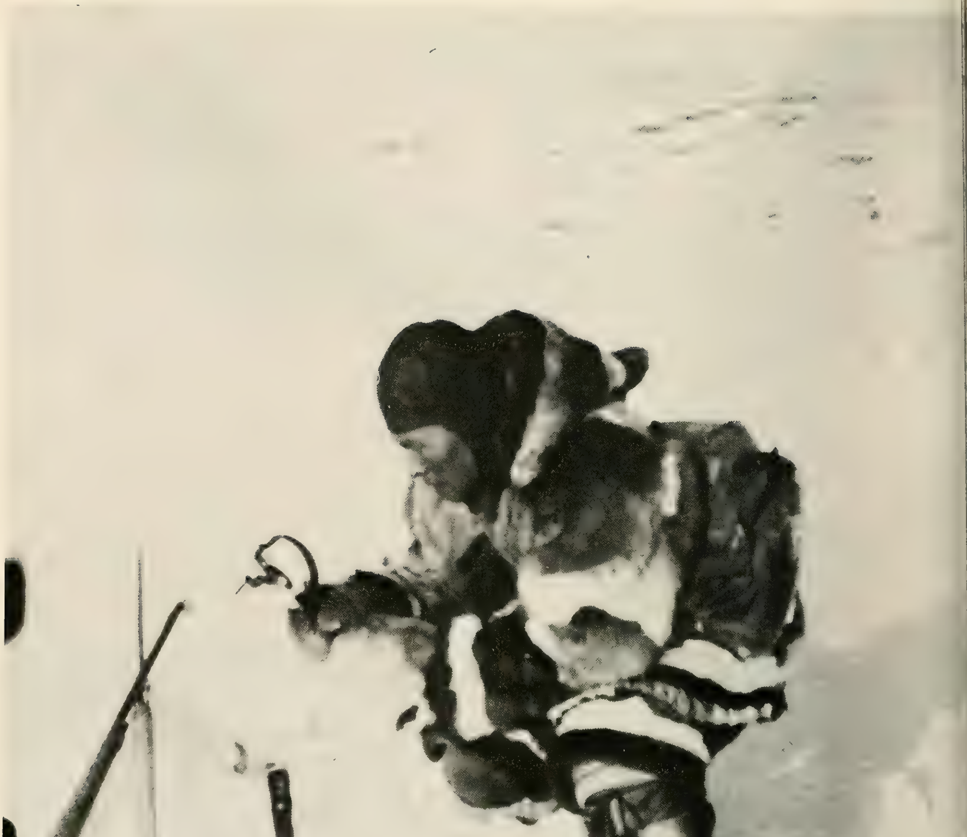
ams. Silt may extinguish entire
nies by suffocating the small bot-
-dwelling invertebrates they feed
by smothering their eggs and lar-
and under extreme conditions,
mothering the adult fishes as well.
he blotchside darter (*Percina bur-*
), formerly abundant in the upper
nberland, has been forced down-
am into Tennessee segments of
stream, and even there it is now
. In the same waters, the Cumber-
l snubnose darter (*Etheostoma*
pinne) and redline darter (*E.*
lineatum) have been completely
rpated from Daniel Boone Na-
al Forest waters, although they
exist elsewhere. And in the upper
ntucky and Licking rivers, the gilt
arrow darters (*Percina evides* and
eostoma saggita) and a third un-
cribed darter species are being
imated by siltation, and the trans-
ent eastern sand darter (*Ammo-*
pta pellucida) has nearly vanished
ler the impact of stream channeli-
on and dam construction.
he minute tippecanoe darter (*Etheostoma tippecanoe*) has an extremely fractionated distribution in Pennsylvania, Ohio, Indiana, Kentucky, Tennessee, and Virginia. Such localized populations are easily destroyed by massive siltation and stream acidification. And, finally, the ashy darter (*E. cinereum*) had long been considered extinct in Kentucky until 1974 when a small population was rediscovered in the Rockcastle River, a principal tributary of the Cumberland. Strip mining has since crept onto the slopes above the river and whether this little fish will survive there much longer is doubtful.

What is happening to the fish fauna in Daniel Boone National Forest should not be taken out of context and scrutinized only as a case study. Fish species in other parts of the Appalachians and the Ozarks, in the Colorado Rockies where oil-bearing shales are beckoning, in the coastal forests of the Pacific Northwest, and in the marginal habitats of the arid Southwest where coal miners are gearing up for a massive assault on newly discovered deposits are subject to the same fate.

The precarious condition of myriads of small fishes should be telling us something about our oft-heralded capacity to understand and order the universe about us. We have learned much about ecological adaptation, about the unique fit of species in the interstices of nature, about the bright fluid streamers we call water. Yet, oddly, we seem to have forgotten that our probing brains and other organs are but slightly different constellations of the same elemental particles that make up fish. ☐

The ashy darter was thought to be extinct in Kentucky until, in 1974, a small number were discovered in a Cumberland River tributary. The fish's markedly different morphology has attracted the interest of researchers.

Robert Stiles



A demonstration for the camera on how to set a fox trap.

How It Really Was

Dorothy Harley Eber

Eskimo photographer has orded a lost moment his people's history

eter Pitseolak took his first picture he 1930s for a white man who was red to approach a polar bear. Peter seolak wasn't too sure it was such ood idea either and he told a fellow nter, "If he starts to move, you y shoot him." But he got the pice, and some years later—either in 42 or 1943—he acquired his own nera. His photographs, taken over wenty-year period, of friends and ations and how they lived in the t days of Baffin Island Eskimo np life are regarded today as part Canada's national heritage. The nadian secretary of state recently de funds available to purchase the gatives and place them on permant deposit in the Notman Phographic Archives of McGill Unisity's McCord Museum.

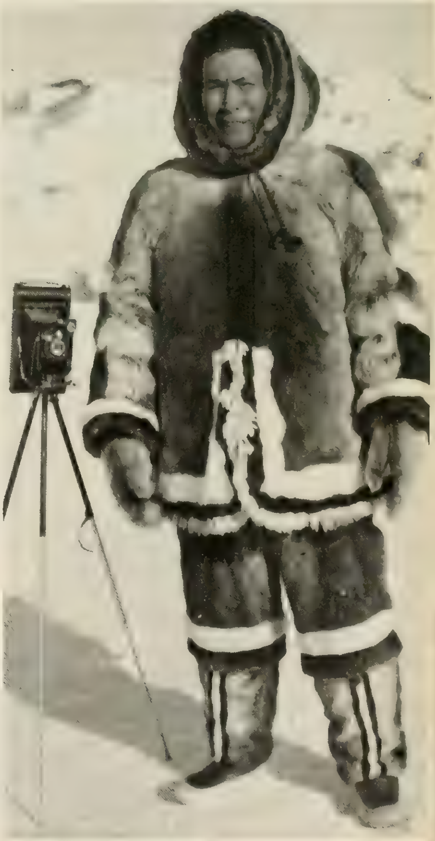
Unfortunately, Peter Pitseolak did t live to see this recognition. He d in 1973 at the age of 71, just four nths after completion of *People m Our Side,* the book we wrote gether. During the time I spent with n, taping interviews with the help young Eskimo interpreters, and in er conversations with his remarkle wife, Aggeok, I learned many tails of how he taught himself phography and of how he and Aggeok veloped the negatives in igloo, nt, and hut.

For me, these pictures, taken iefly just prior to the time Eskimo ved from the camps to the settleents, are a marvelous testament to an's will to try, to his creativity and termination. For instance, to cut wn on arctic sunlight, Peter Pitseok made a filter by filing a pair of dark asses and fitting the amber-colored ass into the head of a flashlight, hich he hung over his lens. Before is, he had had to wait until the sun as low to take pictures. And what d Peter Pitseolak and Aggeok use r light when they developed their gatives in the igloo? "We used a three-battery flashlight and covered it with a piece of red kadluna [white man] material," Aggeok explained.

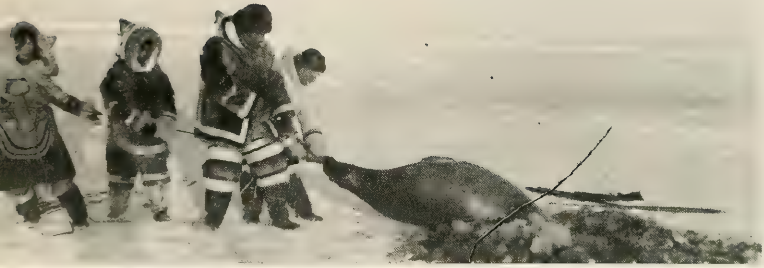
"My first camera was a box," Peter Pitseolak told me shortly before his death. "It was simple to use; you didn't have to set it. Then I got a camera from the Catholic missionary. It was a 122 camera and very heavy. It was a big one. It had settings that could focus on the subject so you could be sure the picture would not be lopsided. When the pictures were taken properly, they turned out very well. Another camera I got from the Bay [Hudson's Bay Company] manager. It was able to expand. It wore out so I took the good parts and used them with the 122. Later my daughter Udluriak got a 620 and I used that sometimes, too."

Peter Pitseolak always referred to his cameras, not by the manufacturer's name or the lens opening, but by the film he used. The various cameras have not yet been properly identified, but five negative sizes have been discovered. Unfortunately, at the time Peter Pitseolak and I were working together, he no longer had any of the cameras he talked about, although his favorite—the 122 camera that took big postcard-sized negatives—is still in Cape Dorset, the settlement where the hunters of the camps of the southwest coast of Baffin Island now live. Peter Pitseolak had lost it in a gambling game to Iyola Kingwatsiak, son of old Kingwatsiak, whose picture he had taken many times and from whom he heard some of the stories he told in *People from Our Side.*

Aggeok recalls that the very first picture Peter Pitseolak took was of her. "He was always practicing on me," she remembers. "He would say, 'Comb your hair and smile!'" Developing the first pictures in an igloo. tent, or hut was "the hard part," Peter Pitseolak admitted. "I watched a man doing it, but I knew he wasn't doing it well. He was a white man but he couldn't develop pictures. I thought to myself, this man is not washing the pictures



Peter Pitseolak and his 122 camera.



The pulling of a captured seal through a hole in the ice was photographed by Aggeok.

This Eskimo and his children are posing before a plastic igloo, one of several in their Cape Dorset community.

enough. So I washed the pictu longer than he did.''

Eventually, both Peter Pitseo and his wife became expert dev opers and printers, and he recall ''People often came to me to le developing—especially the Catho missionary. He thought he knew h but he was using boiling water! Or someone gave me a thermometer test the water but my finger w always best. I used to order the hy from the Bay. Today I have a Pol oid but lately I have been thinking ordering again. I developed a pictu just recently in the X-ray fluid up the nursing station where my neph Elee Parr is working. It came out, was visible.''

Particularly interesting descri tions of the techniques they used a the circumstances in which they d veloped and printed their pictur came from Aggeok. When Peter P seolak got his first camera (he thoug the year was 1942; Aggeok believ it was 1943), he was living in Ca Dorset and working for the Baf Trading Company, and a number the photographs he took at this tin were developed on camping trips igloos. ''When Peter Pitseola wasn't working we would go o camping for a while,'' Aggeok say ''When he was out hunting he wou put the camera on top of the iglo until the film was all used up [in ord not to subject it to temperatu changes]. It was in a case and he use caribou skins to wrap it up. He wou put it on top of the igloo with the do traces over it so it wouldn't blo away. Only after he finished the fil would he take the camera inside an take out the film. The igloo didn't ap pear to be an igloo because we ha a canvas tent inside it, which mad a difference in the temperature. W would develop on top of the sleepin platform with the three-battery flash light and after we did the washing w would keep the negatives overnight i a warm place on top of the box [th box, which was used to store posses sions, would be on the woman's sid of the igloo near the *kudluk*, the sea oil lamp]. We would use two *kudluk* and plenty of oil, which made a goo temperature. An igloo with a linin was good enough even though it wa made out of snow.''

Aggeok says that they used ''thre

of water, two chemical ones,'' eveloping. They used plates that not quite the right size (later acquired regular developing), and to make a measuring cup stuck a piece of paper just below alfway point on a mug. Printing ictures, Aggeok explains, had to ne ''where there was light,'' so rst pictures were printed back in Dorset in their small wooden e. (Peter Pitseolak was one of the Cape Dorset Eskimo to live in a e.) ''When the pictures were to ansferred onto paper we did them r home. The negatives were wa- l in the igloo and the printing was when we got home. We were g oil lamps. To make the prints ould place the negatives with the r in this *tagatujuk* [literally, a mirror,'' but in this instance, nt frame], which had locks that cked and a part would open re you put the negative and the r making sure the paper was the way. Then you would lock it and that was done you would place front of the lamp, which hung the ceiling, counting 'One, . . .' You would make sure you it there long enough because nding on the time, the lightness larkness of the prints would r.'' How did they feel when they ted their first pictures, I asked Ag- k. She replied, ''We were very y; we were laughing and we proud.''

1946 Peter Pitseolak ceased ing the traders in Cape Dorset moved a few miles away to Kea- where ten families lived under his ership. Keatuk was to be his last p; he left it for settlement life in 1. ''I left the camp because my dchildren had to go to school. I afraid they might try to walk e and on the way they could very ly freeze. And I thought if a her or anybody else gave a child rd time, he would be unhappy and to come home. I think the other pers thought the same thing.''

the Keatuk camp, most develop- and printing was done in the *quar-*, a double tent lined with bushes set over a wooden frame, then ked with snow blocks. Many of pictures from the Keatuk period portraits taken prior to Peter Pit- lak's evacuation for TB. ''Because he wasn't feeling well, he would only take pictures when he didn't have to move around too much,'' Aggeok says. They were taken indoors with lighting from the window or from the oil lamps—he had no flash—and are considered by some admirers to be his finest work.

The most frequent subjects are members of the family: Udluriak and Kooyoo, Peter Pitseolak's daughters by his first wife, Annie; his natural daughter, Mary, by Nyla of Lake Harbour; Ashevak, Aggeok's son from her first marriage, and his wife, Mary; and the adopted children and the grandchildren. There are also many pictures of the Keatuk campers and of other relatives and friends. ''When Peter Pitseolak got his camera,'' his half-sister Elleeshushee remarked, ''the skin clothing was just beginning to disappear—many people borrowed my clothing to dress up for his camera.'' Aggeok says, ''He would explain to people that he had learned to take pictures and that he was interested in taking pictures of them. He would know if a person wanted his picture taken or not simply by looking at the expression on his face. Some were simply shy. He didn't want to take pictures of those who didn't want it. He used only to take pictures of people who were happy to be taken. He could tell from the picture afterward if the person had been willing.''

One often-asked question is whether Peter Pitseolak knew he was photographing a disappearing life style. The answer is that he was well aware he was documenting vanishing Eskimo life, although he probably considered his work was for the benefit of his grandchildren. He told me, ''When I was in the hospital with the kidney in the south [his first hospitalization in 1945], I heard people say that many more white men would come to this land. They said, 'The Eskimo will be changed; he will talk like a white man in years to come.' I've always expected this and now it's happening. I'm not surprised.''

Many pictures were set up specifically for the camera. A good example, probably taken by Aggeok, is a series that shows Peter Pitseolak setting a fox trap and then claiming his quarry. ''That's Peter Pitseolak showing how for the future,'' Ag-

Peter Pitseolak's daughter with her husband and baby.

With the help of his niece, Peter Pitseolak prepares a sled's runners for a trip.

A seal feast in Keatuk.

geok explained. Peter Pitseolak also liked to plan pictures purely for the esthetic effect, as is the case with one of his loveliest photographs, the joyous shot of passengers at the back of a sled, raising their arms in the air, almost dancing with delight as they set off on the land. Aggeok remembers that Peter Pitseolak said, "When you start to move, please. . . ."

An important reason for many of the posed photographs was to help Peter Pitseolak with his drawings. In the 1950s, as the traditional Eskimo life style foundered under the impact of the white technological society's northward push, art projects were introduced in the North and supported with Canadian government backing. Particularly spectacular work has come from Cape Dorset and its West Baffin Eskimo Co-operative, owned and operated by the Eskimo. It is said that today there is hardly a gallery in the Western world without a Cape Dorset print. As soon as experiments in printmaking got under way in Cape Dorset, Peter Pitseolak began to contribute skillful and vivid drawings that, like his photographs, document Eskimo life.

One series of photographs Peter Pitseolak took to assist him was particularly ambitious. He had campers at Keatuk act out a well-known adventure of Taktillitak, a man who lived in the lifetime of Peter Pitseolak's father and whose exploits were legendary. While hunting for seabirds, Taktillitak was carried away on an ice floe to a very small island where he ran out of food. He built his own grave and lay down to die, but after dreaming of seals he got up and killed a seal with a club. He made a sealskin float, paddled to shore, and walked to a camp, where his friends were so happy to see him they burst into tears. Photographs, which include an old-style Eskimo grave and the weeping friends, recount the whole story. Sometimes Peter Pitseolak would use the photographs as a guide in drawing; other times, particularly when etching a picture on ivory walrus tusks, he would place carbon under a photograph and trace. "He had less than ten photographs of this kind," Aggeok says, but a number of drawings in the West Baffin Eskimo Co-operative bear witness to the re-
markable skill and ingenuity
which he used these photogra
aids.

There are approximately 1,
negatives in the Peter Pitseolak
lection, but he certainly took m
more. However, many of the ne
tives were ruined. "Sometimes in
hut it got very cold and then it wo
get very hot so some of the negati
got mildewed. I had to burn the
he explained. Nevertheless, a gr
collection remains. Stanley Trig
curator of the Notman Photogra
Archives, says, "The photogra
are extremely valuable because t
document the life of a communit
a certain point in time and were ta
by a member of the community
self—extremely rare in any societ

To celebrate its acquisition of
negatives, the Notman Archives
year hung an exhibition of new pr
made from the earliest of the ne
tives. Aggeok, accompanied
Rosie Kelly, a young Eskimo int
preter, came south for the openi
Rosie was enthusiastic about the pr
ect. She herself couldn't really
member a time when she did not l
in a prefab house. "Sometime
think I remember something ab
life in an igloo and I ask my moth
am I dreaming or is it true?" Lig
years away from her parents' gene
tion, she looked at their beautifu
tailored skin clothes in Peter Pits
lak's pictures and said with wond
"They had everything we have, ev
panties, but it was all in caribou
Her favorite pictures, however, w
those in which Peter Pitseolak set
situations to "show how for the
ture." "It blows the mind," she sa

Aggeok also knows the pictures
"useful." She puts it this wa
"Speaking only for myself the us
fulness of the pictures is that one c
look into the past and see people w
are no longer alive—who have be
dead for a long time. They can
seen through the pictures and th
makes me happy. Also, they are us
ful for remembering what it was li
in the past. You can look at the pi
tures and start talking about how
used to be. Those are the things I fe
are important." And then, as an aft
thought, "The schoolchildren
Cape Dorset have the pictures on t
walls. They tell me they see from t
pictures how it really was."

thusiastic passengers setting off on a sled trip.

The Fly That Would Be King

by Robert S. Desowitz

The results of conquering trypanosomiasis might be more devastating for Africa than the disease itself

This African tyrant does not attend political councils, is not a member of the Organization of African Unity, and has not palavered with roving diplomats, but it does have a personal air transport system—the tsetse. Holding Africa in thralldom since ancient times, this parasite, known as a trypanosome, is only six ten-thousandths of an inch long, but it has affected the economy, social institutions, and even the religious complexion of the continent.

During the mid-nineteenth century, Muslim Fulani cavalry swept from their near-desert west African Sahel kingdom into the savanna to the south and east, conquering and converting the animist tribes with whom they came into contact. But in their progression through woodlands and forests they encountered a formidable adversary, the tsetse. Swarms of these flies attacked and bit the horses, transmitting the parasite to them, which resulted in a lethal form of animal trypanosomiasis. In rapid o
the cavalry became a disarrayed
fantry. On foot, the Fulani were
tually powerless; their invasion
halted before it could reach the g
population centers of the Benue
Niger river valleys. Thus was Isl
with its sociopolitical consequen
prevented from infiltrating this v
densely peopled region of Africa
more than half a century.

The popular notion of trypanc
miasis is depicted by the lethar
human suffering from the "sleep
distemper," as an English obser
described it some 200 years ago.

A tsetse feeding on a small animal

rm of distemper at all, the infec- in man is caused by one of two ely related parasitic organisms, *anosoma gambiense* and *T. rho-* *ense*, and in animals by *T. bru-* *T. congolense*, and *T. vivax*. (*T.* *biense* was thought to be a para- restricted to man but researchers recently implicated the pig as a rvoir host.) Both animal and an trypanosomes are transmitted e tsetse, a bloodsucking fly of the s *Glossina*. Tsetse inhabit Africa south of the Sahara, from ap- imately 15 degrees north to 20 ees south latitude, although they once had a wider distribution, as evidenced by the discovery of a fossilized tsetse in the Oligocene shales of Colorado. While human trypanosomiasis continues to be a public health problem, responsible for some 7,000 deaths each year, it is the infection in domestic animals that has had the greatest impact on African development.

The tsetse belt encompasses more than six million square miles of land denied to livestock production, mixed farming, and in some regions, human settlement. It is an area that could potentially provide 125 million head of cattle to the protein-starved continent. The disease has forced herdsmen to concentrate their stock on the limited amount of fly-free pasturage, which has led to overgrazing and attendant soil erosion. When cattle are trekked to distant markets through fly-infested country, some 25 percent of the herd may die before reaching their destination. And yet, a less anthropocentric view might hold that by preventing overexploitation of this enormous area, the tsetse and the trypanosome are the most stalwart guardians of the African ecosystem and its magnificent wild fauna.

J.A.L. Cooke; Bruce Coleman, Inc.

oto Researchers

like many antelope
:s in sub-Saharan Africa
ict as reservoirs for
nosomiasis, have evolved an
ne response to the parasite.

e manner and degree of trans-
on of trypanosomes involves
lex interactions of parasite,
and fly vector. With this in
, let us consider the scenario and
atis personae of *The Fly That*
'd Be King, an African spectac-
vith a cast of millions.

t one is set in a forest in Africa.
age is the host, either a man,
or antelope. A closer, micro-
c examination reveals the sec-
character, the trypanosome,
ming about in the blood of the
y means of an undulating mem-
and lashing flagellum. A sound
gy buzzing comes from offstage.
a tsetse, a brown insect not
larger than a housefly. The
smells and sights the host, then
s and bites, sucking in its
nosome-containing blood.

t two takes place inside the
's gut, where the trypanosome
gates and multiplies by simple
ual division. After about four
it migrates to the fly's salivary
ls where, over the next fifteen
, further transformation takes
until it assumes a short, stumpy
arance. This is the metacyclic
, the terminal developmental
capable of infecting a new host.

t three opens in the forest twenty
later. The original host lies ob-
sly ill on the stage floor. Enter
her host. The infected tsetse
es, delivering the metacyclics to
loodstream of the new host and
pleting the cycle. Curtain.

hile this plot is essentially the
e for all African trypanosomes, the details for each species differ in inportant respects. In man, the disease caused by *Trypanosoma gambiense* is of a chronic, malignant nature and gives rise to the torpor and eventual coma and death classically associated with sleeping sickness.

The pathology of the disease is largely unknown. Over the course of time, the trypanosomes tend to leave the blood and enter, first, the lymphatics, and later, the spinal fluid and the tissues of the central nervous system. During this latter phase, the patient becomes comatose and dies after several years if he has not received chemotherapeutic treatment.

Whereas Gambian sleeping sickness results in a slow death, that caused by *Trypanosoma rhodesiense* kills its victim within weeks or months. Besides a difference in the degree of virulence, the two infections differ in other respects. Gambian trypanosomiasis is essentially a human disease cycled from man to man, while Rhodesian trypanosomiasis has a third host in the transmissive cycle—the wild antelope—which acts as a reservoir of infection. By all biological criteria, *T. rhodesiense* is a parasite of the wild ungulates, rather than man. It has evolved to a state of equilibrium in the animal host and produces no overt disease. Man, for the most part an accidental host, has not attained this accommodation, as reflected by the intense virulence of the human disease. The manner by which the antelope modulates the infection remains a mystery but its elucidation might aid in devising a means of similarly stimulating a protective state in man.

The ecological setting—the landscape epidemiology—of the two disease varieties are different. Gambian sleeping sickness is generally restricted to the humid forests bordering the lakes and rivers of west and central Africa, the obligatory habitat of the *Glossina palpalis* vector, the tsetse species that transmits this form of the disease.

Because rural African populations rarely have the means to obtain water from distant sources, communities tend to form along the banks of rivers and lakes, and village activities—bathing, washing, drawing water, and fishing—take place at the water's edge, making for intense man–fly contact. Epidemics flare from time to time but generally the disease level is low because the tsetse is, biologically, a relatively inefficient vector. Trypanosomes can readily multiply in *Glossina palpalis* only shortly after the fly emerges from the pupal stage. Therefore, very few older flies are able to act as successful vectors after feeding upon infected humans.

Sleeping sickness caused by *Trypanosoma rhodesiense* is endemic to the dry savanna woodlands of east and central Africa, the mutual habitat of the *Glossina morsitans* vector and the great herds of antelope that serve as reservoir hosts. Human infections occur when man settles or intrudes into the savanna to hunt, gather wood, or graze cattle. The species of vector that transmits this form of the disease is not an equal opportunity biter and prefers to take a blood meal from mammals other than humans. When game becomes scarce, however, the fly will feed on man. Apparently attracted to large, slow-moving objects, the fly's instincts become confused when these sometimes turn out to be vehicles, and it will feed on the passengers. In this curious way, a package tour of east African game parks occasionally includes trypanosomiasis.

There is, then, an intimate relationship between the nature of the ecosystem and the epidemiology of trypanosomiasis. The history of Africa, however, is characterized by continuous ecological change—felled rain forests succeeded by grasslands and savanna woodlands, an advancing or retreating desert, and shifting distribution or concentration of man and the wild fauna. These environmental changes have played a crucial role in the epidemiological patterns of the Gambian and Rhodesian forms of trypanosomiasis, particularly where their ranges overlap in east-central Africa.

The activities of both Africans and colonial expatriates and their diseases have also contributed to the epidemiological status of trypanosomiasis. Before the nineteenth-century colonial period, trypanosomiasis was confined to a relatively few, smoldering foci. Internecine warfare and lack of roads restricted communication and prevented the spread of the infection. The rapid dissemination of

ı—high producers of milk and
adapted to semiarid regions—
ı die of trypanosomiasis.
e less productive breeds
immune to the disease.

witz

sleeping sickness can be traced t
opening up of Africa by the colo
powers. It was the *Pax Britannic*
much as the tsetse that was respo
ble for the broadcast of infect
How this complex of changing e
ronmental and human factors ha
fluenced epidemicity of the two t
of human trypanosomiasis is i
trated, par excellence, by the ev
that have occurred along the Ke
and Uganda shores of Lake Vict

Prior to human settlement, the
was surrounded by a tropical l
forest. Primitive agriculturists
grated to the lake's shores and fe
forest tracts for their shifting farm
Forest-inhabiting tsetse were pres
but human trypanosomiasis was
sent. Eventually, deforestation
gressed to such a degree that gr
lands replaced large areas of for
forest. The grasslands then attra
a second wave of migration—Nil
pastoralists and Bantu cultivat
The combined pressures of gra
and agriculture suppressed forest
generation and thus maintained a
free area beyond the forest
fringed the lake.

In the nineteenth century this s
ety was devastated by the twin pe
lences of smallpox and rinderp
Before the population had time to
cover, savanna woodland succee
the grassland. At the close of
nineteenth century the ecolog
stage was set for sleeping sickn
The shores of the lake were borde
by a high forest infested with
tsetse vector of *Trypanosoma g*
biense. Beyond the forest *Gloss*
morsitans flies capable of transı
ting *T. rhodesiense* inhabited the
vanna woodland. Still the trypa
some had not made its debut.

The parasite is thought to h
been introduced when Sir He
Morton Stanley, employed at t
time in the Congo by the Belgia
mounted an expedition in 1887 to
area of Lake Victoria. Natives
Stanley's retinue, probably infec
with *T. gambiense,* may have carr
the seeds of the epidemic that wa
decimate the population for the n
ten years.

By 1910, when the Gambian sle
ing sickness began to burn itself c
the number of inhabitants in the a
had declined from 300,000 to 10
000. Before the epidemic, the s
and number of human settlements l
the effect of suppressing the fau
population; but as people died of
disease or fled the stricken area,

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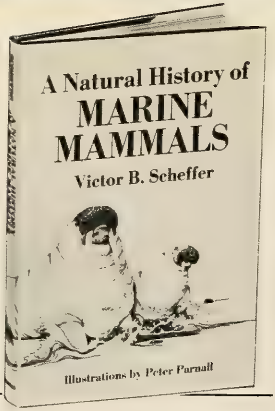

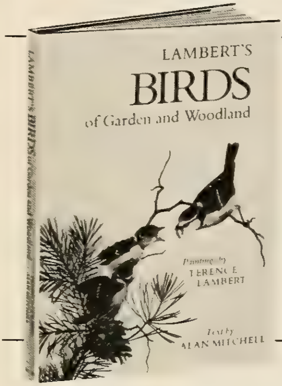

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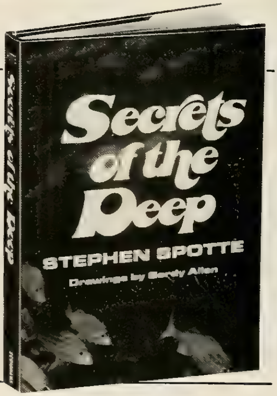

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reservoirs of *T. rhodesiense* 1 into the adjacent savanna and. The epidemiological link Rhodesian sleeping sickness from game to man through land-dwelling fly was now it to complete the cycle. When nment-inspired resettlement ttempted in the 1940s, the mi- rapidly became infected with ighly lethal disease and once the inhabitants deserted the Today, this potentially rich re- s virtually abandoned, occupied by a few fishermen who are at isk of contracting the infection. e trypanosomes that infect do- c animals are not restricted to articular forest ecosystem; ani- rypanosomiasis exists wherever are tsetse of any species. The nce of wild game reser- —and the high probability that ies carry these trypanosomes— ibutes to a level of transmission ense and ubiquitous as to effec- preclude stock production in ourth of Africa. Nomadic and settled cattle-owning tribes have forced to pasture their animals fly-free zones in and near the Sahel. As the dry season ap- ches, the Sahel is no longer able stain the herds and there begins nual seasonal trek into the fly- ted Guinea savanna. Losses to nosomiasis always occur, but e nutrition is adequate and the ity of flies not too great, the stock manage to survive, if not ish.

e breed of cattle favored by the an pastoralist is the zebu, a , humpbacked longhorn, well ted to semiarid conditions. Al- gh it produces a relatively high l of milk and meat, the zebu has nfortunate disadvantage of being eptible to trypanosomiasis. re are smaller, some dwarf, ds of cattle, such as the N'dama Muturu, that possess a remarka- igh resistance or tolerance to the nosome. Studies carried out at Nigerian Institute for Trypanoso- is Research have proved that the tance of these small breeds is due highly efficient immune re- se. Two conditions are necessary e attainment of this level of pro- ve immunity. First, the animals t be born of a hyperimmune dam, second, they must receive an and continuous infection of anosomes so that they produce a ctive antibody.

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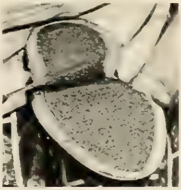

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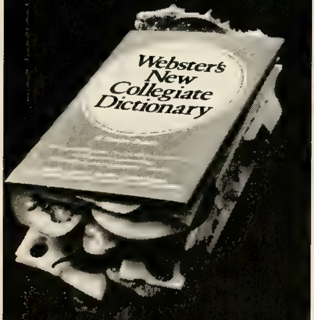

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These tolerant breeds have not as yet been economically exploited, probably because of their small size, although the N'dama is sufficiently large to be used for meat purposes. Crossbreeding with zebu or European breeds does not result in offspring capable of developing a hyperimmune state.

Combating trypanosomiasis calls for heroic measures but side effects of the remedies may be too severe to be practicable. The battle against the disease has included massive alteration of the environment, social dislocation, wholesale slaughter of the wild fauna, and mass administration of toxic drugs. A commonly employed means of control has been to deny the tsetse its required habitat by selective or large-scale deforestation. Fly-free zones can only be maintained by intensive land use brought about by the collectivization of the population into large agricultural villages and townships. This forced dislocation from the traditional, stable life in small, scattered tribal groupings has resulted in a disturbing upheaval of the social order.

Perhaps the most controversial control measure was the game destruction program carried out in east Africa during the 1950s. Designed to open land to human settlement, the logic of this scheme was faultless. Game harbor *Trypanosoma rhodesiense* and are the main source of blood for the tsetse; therefore, destroy the large fauna and good riddance to both fly and trypanosome. After the campaign, however, sufficient numbers of small mammals survived to support the fly population. Also, as the game were decimated, herdsmen moved their cattle into the cleared areas, and the fly was diverted to feeding on the livestock and the pastoralists, resulting in a continued and intensified transmission of both animal and human trypanosomes. Finally, revulsion against this studied slaughter brought the program to a halt.

Another potential control measure has been the use of insecticides. Ironically, one researcher has proposed that this means was a major, if not prime, contributor to the great drought that recently ravaged sub-Saharan Africa. The reasoning of this hypothesis is as follows. Increasing urbanization and prosperity in west Africa precipitated a demand for meat. Traditional cattle-owning tribes increased the size of their herds to match the market. Widespr government-sponsored aerial sp ing of insecticides, in conjunc with mass chemoprophylactic injections of cattle, followed, per ting growth of herds not only ir Sahel but also in the adjacent Gui zone savanna. The large numbe cattle overgrazed the meager st of grass and other plant life in fragile ecosystem, resulting i higher reflectance of sunlight f the denuded land. There is good dence that such a situation caus decrease in rainfall and in this re proceeded to such a point as to duce climatic havoc.

Despite more than seventy yea research and effort, the freeing Africa from trypanosomiasis has been realized. Effective, practic means of control are either lackin too harsh. Except for limited ar insecticide spraying is too cos Governments of the new African tions are often too poor in econo and technical resources to main the anti-trypanosome and -tsetse grams begun during the colonial

Although human trypanosomi has declined due to drug treatmen infected people, the trypanoso can develop resistance. Confron with this impâsse, scientists h long sought the biological "ma bullet"—immunization—as a s tion to the problem. Vaccination brought many of the great scourge mankind, such as smallpox and low fever, under control without cessitating change of the environm or turmoil to the socioecono order. But unlike the immunolo cally amenable bacterial and v pathogens, the trypanosome has c founded all attempts to induce prot tive immunity. The reason for failure stems from the parasite's a ity to elude the host's immune fense by a process known as antige variation.

There is currently great conc over the antigenic shift of the in enza virus, a phenomenon that see to occur about every ten years. trypanosome undergoes the sa process but the antigenic vari arises every five to ten days. Thi tantamount to the host being saulted by a new, personal epider each and every week.

During the course of a trypano mal infection the host may devel antibody that eliminates most, but all, the trypanosomes. These sur vors are of a different antigenic ch

, which the antibody fails to rec- :e. The variant trypanosomes begin to proliferate in the blood- n. The host responds by produc- new specific antibody. The ss is repeated over and over , the trypanosome possessing markable ability of producing a , probably infinite number of enic variants.

he underlying mechanism nsible for antigenic variation een the subject of a long contro- between those who hold it to be lective process, which presup- s a starting parasite population of predominant and many minor nts, and those who believe that enic variants arise by mutation. e are difficulties in supporting ei- of these explanations on the basis xperimental evidence, and re- ly some researchers have postu- that the antibody itself somehow ces the chemophysical transfor- on of antigen structure. Electron oscopy and immunochemical ysis suggest that the trypanosome gen—the face the parasite ents to its world—is a glycopro- coat, or pellicle, situated outside trypanosome's limiting plasma membrane. It appears that this coat is periodically shed and the parasite, acting as its own couturier, designs and makes a new antigenic garment.

Trypanosoma vivax, the important pathogen of livestock, seems to have developed still another maneuver to survive in the immunized host—antigenic mimicry. This trypanosome may be able to absorb a coat of host serum protein that disguises its alien status and also acts as a protective shield against any antibody that the host may produce. A similar phenomenon, the absorption of host substances to the external parasite surface, occurs in the schistosome blood flukes of man. Antigenic disguise may thus be an important adaptive evolutionary strategy to permit some parasites to exist in the immunized host.

New methods for dealing with human and animal trypanosomiasis are urgently needed. The amount of research and resources invested, however, are minuscule compared to the magnitude of the problem. A new trypanocidal drug has not been added to the chemotherapeutic armamentarium for twenty years. Pharmaceutical companies candidly admit that the high cost of development and the potentially poor profits from selling to the generally impoverished underdeveloped nations have virtually taken them out of tropical disease research. I feel confident, however, that improved means of combating the infections will eventually be forthcoming. A quality of biomedical science is its incurable optimism that all things are possible given time and support.

But it may well be that Africa's real problems will commence with the effective control of trypanosomiasis. Scientists and the administrators carrying out the practical applications of research often fail to recognize that they are engaged in a gigantic chess game. As one enemy piece is captured, other pieces move to threaten. As trypanosomiasis is conquered, overgrazing, soil erosion, social disruption, and faunal extinction may result. Until such time that scientists and their technical-administrative partners appreciate the grand strategy to act sanely and effectively to protect the well-being of all Africa's citizens, both two-legged and four-legged, we might applaud the cosmic wisdom that has made the tsetse, rather than man, Africa's custodian. ☐

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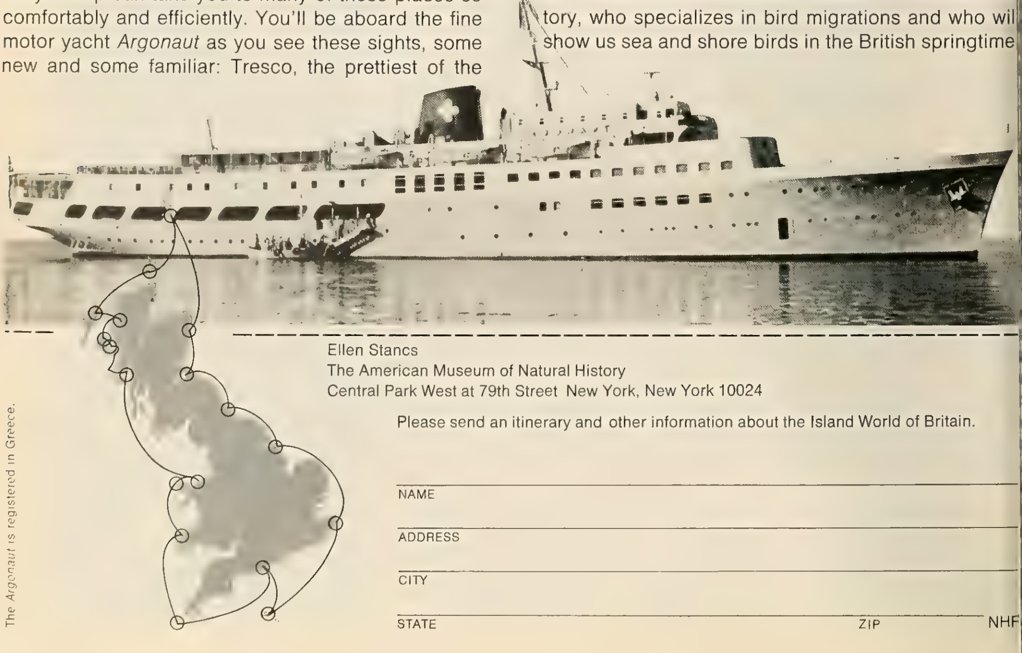

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June 1959, a world authority on
opes, who was also director of
or observatory in Arizona, told
Francisco audience of his esti-
of the bright prospects for mak-
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bing blanket of the earth's at-
here, he predicted, would make
sible to study the kinds of light,
as ultraviolet radiation and X
that do not penetrate to the
nd. However, he ruled out one
n of the spectrum a priori. That
he so-called extreme ultraviolet
'), consisting of light with wave-
hs from 100 to about 1,000 ang-
ns. (An angstrom, named for the
lish physicist Anders Ångström,
unit of length equal to approxi-
ly four-billionths of an inch. Or-
y ultraviolet light extends from
) to 3,000 angstroms, while vis-
ight ranges from roughly 3,000
,000 angstroms. X rays have
lengths shorter than 100 ang-
ns.) The expert from Arizona
cted that "space is going to be
hazy" in the EUV wavelengths.
to the absorption of that light by
atoms in interstellar space, it
ed likely in 1959 that only the
and perhaps the nearest stars
d ever be seen in the EUV.

the course of the next sixteen
s, a series of rocket and satellite
riments did indeed open up new
zons of exploration for astron-
rs, allowing them to map and
sure the celestial sources of X
and ultraviolet light. During this
, a few rockets were launched to
y the EUV as well, but without
rent success. It was not until July
that NASA astronauts partici-
ng in the joint United States-
R *Apollo-Soyuz* space mission
eeded in detecting EUV radiation from objects outside the solar system. These stellar sources included one, known as HZ 43, at an estimated distance of 210 light-years from the earth and thus well beyond the nearby stars. It appears that HZ 43 may be the hottest and brightest star of its type yet found and that these properties may help us to deduce the circumstances of its past and future evolution. For a group of physicists from Berkeley, California, the *Apollo-Soyuz* discoveries were the happy climax of a campaign to convince other scientists that EUV wavelengths were not, as someone had put it, "the unobservable ultraviolet."

The rationale for attempting to survey space in the EUV was threefold. To begin with, it is a matter of record that as each new range of wavelengths has been explored by astronomers, beginning with radio waves in the 1930s, unsuspected celestial phenomena have been discovered or, at least, new aspects of known objects in the sky have been revealed. It was conceivable, therefore, that the most interesting results of EUV astronomy would be exactly those that could not possibly be anticipated.

Secondly, stars with surface temperatures of about 100,000 degrees centigrade would emit light predominantly in the EUV. Although no normal-sized or large stars of so high a temperature occur, it is known that some small hot stars of those temperatures do exist at the centers of planetary nebulae. These nebulae are expanding shells of gas produced when red giant stars shed the cool, outer layers that surround their hot, central cores. The central star of a planetary nebula is the remaining hot core of a red giant.

It is believed that central stars cool down as the expanding nebulae dissipate into space, and they eventually become the well-known white dwarf stars, with temperatures of 50,000 degrees and less. However, astrophysicists disagree about the rate

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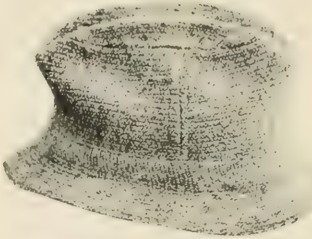

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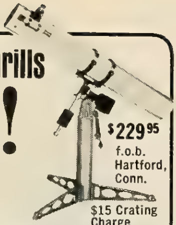

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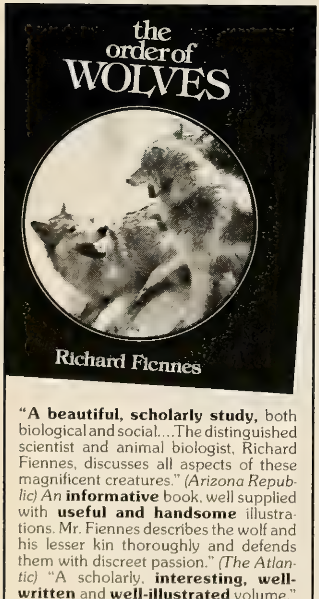

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of the cooling process. If the central stars cool down rapidly to 50,000 degrees or less, then few stars hotter than 50,000 degrees will be found. But if the cooling is long and slow, then there may be many hot dwarf stars intermediate in their properties between the central stars of planetary nebulae and the common white dwarfs. These stars would be old enough to have had their nebulae dissipate and thus the only or most feasible way they might be recognized as hot dwarfs could be through their strong EUV radiation. If it were possible to count the numbers of such EUV sources, we might be able to estimate the rate of the cooling process of central stars and thus settle an important astrophysical argument.

The final reason for surveying space in the EUV is a theory about physical conditions in the interstellar medium according to which this tenuous gas in space is heated by EUV radiation. Alternative theories ascribe the heating variously to X rays, cosmic-ray particles, or supernova explosions. EUV studies might thus establish which theory is correct.

Were there really any prospects for success in EUV astronomy? Many astronomers shared the Arizonan's misgivings. The fundamental objection was that space is supposedly opaque to EUV light due to the strong absorbing properties of hydrogen and helium in the interstellar gas. According to one estimate, for example, even using instruments of the highest attainable sensitivity, the EUV light of our own sun could not be detected from as small a distance as only three light-years. Yet the nearest star to the solar system, Proxima Centauri, is four light-years from the earth.

On the other hand, the Berkeley scientists, led by C. Stuart Bowyer, a space physicist whose outlook is that objections are made to be overcome, argued that the astronomers' pessimism was based on theory rather than fact. It was possible, the Berkeley group thought, that the interstellar gas is distributed in a very patchy manner, so that the EUV light of some stars might pass between the clumps of absorbing gas and thereby reach the earth. Further, they cited evidence that has led some astronomers to conclude that the solar system is located in a region of space where the interstellar hydrogen gas is thinner than average. This would allow us to "see" farther into space in the EUV than had been calculated.

Of course, they pointed out, ce kinds of stars must produce r more intense EUV radiation tha sun because the hotter the object shorter the wavelength at whic greatest light emission occurs. jects like the central stars of plan nebulae and the hot dwarfs inte diate between these stars and white dwarfs might be visible at r greater distances in space than sun, when searched for with l telescopes.

It was also suggested that some atively ordinary and well-kn stars, with surface temperature only 10,000 degrees, might hav yet undetected coronas, that is, t million-degree-hot, outer at spheres like that of the sun (*see* " Turbulent Sun," *Natural Hist* November 1976). If these cor were much more extensive than of the sun, as some calculations i cated, they would also produce st EUV light because of their great r and high temperature.

The campaign to explore spac the EUV began with rather primi instruments carried on rockets aloft to record information above lower levels of the earth's atmospl at various altitudes. One such ro instrument was launched from White Sands Missile Range in N Mexico in October 1971 and agai March 1973. The experimenters charge of those missions reported no EUV sources were detected or ther occasion. The Berkeley gro following a different experime philosophy, also built a rocket ins ment and launched it from W Sands in June 1972 and in Febru 1973. Their rocket flights too negative results.

Then, with the assistance of astronomers from the University C lege, London, Bowyer and his Ber ley colleagues flew a modified vers of their instrument in February 19 This time the flight was made fr Woomera, South Australia, sinc was intended to look for any E sources that might exist in the sou ern sky. The results were again dis pointing, but the evaluation was verely hampered by the failure of onboard, visible-light camera use photograph the constellations dur the flight and determine the direct of viewing. As a result, the data ar ysis was unexpectedly complica and time consuming, and it was until after the *Apollo-Soyuz* miss took place in 1975 that the Ber ondon collaborators realized inbeknownst to them, they had ly detected an EUV star in the t flight of the previous year. On ame rocket flight, the payload ery parachute also had failed, ing in the destruction of the instrument and thus dramati- ending what seemed at the time a series of consistently dis- ging experiments.

basic limitation of the EUV t experiments was the short du- of a typical flight. A few min- after the instrument was hed above the absorbing region earth's atmosphere, it inevi- fell back toward the ground. To sensitive observations that were significant, a larger telescope much longer viewing periods needed. The opportunity for conditions came during the July 24, 1975, *Apollo-Soyuz* Test ct. This was the celebrated inter- ial space mission in which three A astronauts in an *Apollo* craft docked in orbit, 135 miles the earth, with the *Soyuz-19* manned by two Soviet cosmo- .

e more complex 14½-inch-di- r EUV telescope developed at ley for this mission was classi- s a "unilateral" experiment, ing that it required the services NASA crew only and, in fact, not operated until the joint-mis- activities had concluded and had separated from *Apollo*. In esign of this telescope, the ex- nenters had reverted to the con- n which the earliest EUV rocket iments were based, namely, a lar field of view directed at pre- ted targets. The telescope was d by literally maneuvering the *Apollo* command and service ile to point the instrument at of thirty carefully chosen white fs, planetary nebulae, and other sting celestial objects. In addi- the instrument was exposed to ky at certain other times, when crew was maneuvering the craft to meet the needs of other iments aboard *Apollo*. In all, a of about twenty hours of useful sure time was obtained, which nts to about 200 times the total ving time of an average earlier t flight.

us far, analysis of the data tapes the *Apollo-Soyuz* experiment evealed the presence of EUV ra- n from at least four stars. One star was so bright in the EUV that it was recognized as a source even during the mission, when raw data transmitted from *Apollo* were displayed on a chart recorder at the Johnson Space Center in Houston. Bowyer was so surprised, he said, that "it almost blew us off the console panel." In a press release, the University of California claimed that the discovery of intense EUV light from this star, HZ 43, proved that EUV research, which "few thought possible has more potential than even the most optimistic group had anticipated." The editor of the trade magazine *Aviation Week* acclaimed the discovery, noting that "this area previously was thought to be forever screened from man's observation." In truth, the discovery was nearly missed. As the time allotted to the EUV astronomy measurements was running down, a key associate of Bowyer, Bruce Margon, discovered that one of the thirty preselected targets apparently had not been observed as planned. After a certain amount of argument and rechecking, the investigators prevailed and the order was given to point the telescope toward the overlooked target. The target was HZ 43, which was to become the great scientific success of the mission.

HZ 43 is located in the northern constellation of Coma Berenices. As far back as 1971, Japanese physicists had detected an X-ray source in the region, as had Margon in 1974. Then in 1975, physicists at the Massachusetts Institute of Technology, using the *SAS-3* X-ray satellite, localized the X-ray source to the region of HZ 43. From the *Apollo-Soyuz* observations, it became clear that this star was indeed the source of both the EUV radiation and the X rays, although the majority of its energy is emitted in the EUV. It also seemed that the star must have a temperature of about 110,000 degrees to account for the radiation. HZ 43 is a white dwarf star that had been studied at the Hale Observatories in California in 1972. Analysis of its dim visible-light spectrum, as recorded with the 200-inch telescope on Mount Palomar, had led a young Hale astronomer to conclude that the surface temperature was 50,000 degrees. Further, this estimate was said to be accurate to within 10 percent and was thus in clear conflict with the EUV measurement. The disagreement was important since there were no known white dwarfs hotter than 50,000 degrees.

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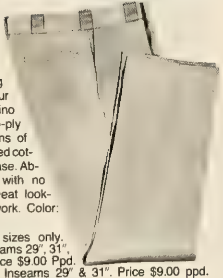

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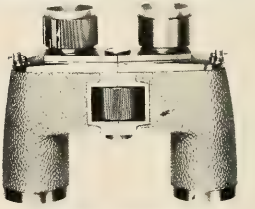

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A world authority on white dw at the California Institute of Tech ogy publicly expressed some rese tions about the EUV measurem shortly after *Apollo* returned to ea When I met him over lunch abo year later, he still held a strong pre ence for the lower temperature mate. The Berkeley scientists, h ever, insisted that since the bul HZ 43's energy, perhaps as muc 97 percent, is produced in the E that wavelength range is the most able one for gauging the star's ph cal condition. They gained sup from theorists at the NASA-A Research Center at Moffett Fi California, and at the University Rochester, who analyzed the E and visible-light data in combina and concluded that 125,000 deg was a better estimate. On the o hand, computations done at the H Altitude Observatory in Boul Colorado, and at the University Delaware suggested that the temp ture of HZ 43 is actually in the ra of 55,000 to 70,000 degrees, depe ing on the amount of helium in star.

The Berkeley physicists seeme have adopted a compromise valu about 80,000 degrees in Aug 1976, when they summarized t findings on HZ 43 at an internatio symposium in Grenoble, Fran They concluded that HZ 43 is both hottest and the most luminous w dwarf yet found. It radiates twice much energy as our sun, althoug is slightly smaller than the earth. such a high temperature, HZ 4 nearly as hot as some of the cen stars of planetary nebulae from wh white dwarfs are supposedly scended. But its spectrum shows trace of helium, whereas the neb stars always have helium. This represent a fundamental cont diction of the theory of stellar ev tion. It is also possible that there be a less drastic and more satisfy explanation.

The Berkeley physicists point that as the central star of a planet nebula shrinks to become a w dwarf, its gravity will intensify. some point, the gravity will be str enough to cause atoms of helium the heavier gases to diffuse dow ward below the visible surface of star, leaving an atmosphere of nea pure hydrogen, the lightest gas. 43, as a star intermediate between planetary nebulae stars and the o nary white dwarfs, may have only

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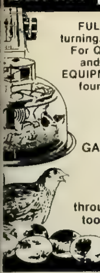

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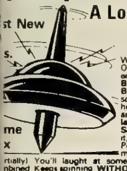

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cently undergone this diffusion process. If so, it is truly a unique object for astrophysical study.

Another hot white dwarf, called Feige 24, was also detected with the EUV telescope on *Apollo-Soyuz*, as were the stars SS Cygni and Proxima Centauri. Investigations of the latter two stars are still under way, but they too should be of considerable interest. SS Cygni is a dwarf nova, that is, a binary star in which eruptions occur at intervals. Since it was a selected target of the *Apollo-Soyuz* experiment, ground-based astronomers were alerted to keep it under watch. While the mission was in progress, the Berkeley group received a telephone call from the director of the American Association of Variable Star Observers in Cambridge, Massachusetts, who called to say that by a great stroke of luck, SS Cygni was undergoing an eruption at the very moment.

Proxima Centauri, as mentioned above, is the nearest star to earth beyond our sun. It is a cool red dwarf and on that account would not be expected to produce any EUV light worth mentioning. However, it is also a flare star, the occasional site of events like the flares that erupt on our sun, but ones that are much more powerful. Solar flares produce strong EUV radiation for brief intervals. Since the Berkeley telescope detected EUV radiation from Proxima Centauri, one wonders whether, by a second stroke of incredible good luck, this star actually flared at just the time that the *Apollo* astronauts maneuvered their spacecraft to point the telescope at the star? Since Proxima is located in the deep southern sky, an astronomer at Mount John, in New Zealand, was hired to monitor the visible light of the star during the space mission. But at the time of the EUV observations, it snowed on Mount John and viewing was impossible.

The *Apollo-Soyuz* observations also confirmed that the solar system is located in a region of lower than average interstellar gas density. This finding explains why the optimists prevailed in EUV astronomy, for had we been located somewhere else in the galaxy, in a denser, more opaque medium, the EUV wavelengths would truly have been the "unobservable ultraviolet."

Stephen P. Maran is an astronomer at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

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Celestial Events

by Thomas D. Nicholson

Sun and Moon Until mid-February, the sun moves eastward through the stars of Capricornus. About the 16th, it moves into Aquarius and about March 12 into Pisces. In this part of the ecliptic—the sun's apparent path through the stars—it shifts rapidly northward toward the equator. The lengthening of the day that results is quite apparent, with daylight becoming almost 12 hours long by mid-March.

After the full moon of February 4, the moon is in the morning sky until nearly the last week of the month. Last-quarter is on the 10th, new moon on the 17th, the early evening crescent should show up by the 20th or 21st, and first-quarter is on the 25th. In March, we will start out with a waxing evening moon, with full moon on the 5th and last-quarter on the 12th.

Stars and Planets Three planets stand out prominently among the bright evening winter stars this month: Venus—low in the west from shortly after sundown until it sets about three hours later; Jupiter—well above and to the left of Venus and second only to it in brightness among the evening stars; and Saturn—still farther left, rising in the east almost opposite the place where Venus is setting. Jupiter and Saturn remain in the sky well into the night (Saturn nearly until sunrise), and they will be useful guides to nearby stars this month. Jupiter can help locate the two prominent star clusters in Taurus (the Pleiades, above Jupiter, and the Hyades, to its left). Saturn is in Cancer, with no bright stars near it, but it can guide you to Pollux and Castor (Gemini) and Procyon (Canis Minor) to the west (right) and to Regulus (Leo) to its east (left). The other two naked-eye planets, Mercury and Mars, are morning stars this month, but poorly placed for viewing.

February 3–4: The bright star within the glow of the full moon tonight is Saturn.

February 11: The moon is nearest the earth (at perigee).

February 16: Mercury and Mars are in conjunction with the moon, but they rise too late in the dawn to be seen.

February 21: Venus and the evening crescent moon make a pretty pair in the sunset sky tonight.

February 24: The moon has moved to the vicinity of Jupiter tonight, passing closely beneath the planet at about 5:00 P.M., EST, then moving off slowly to the east (left). It is at apogee (farthest from earth) today.

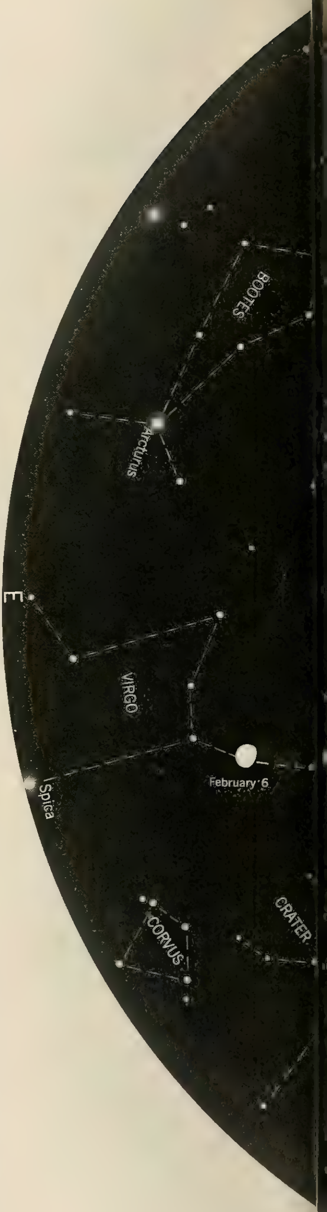
February 28: Venus reaches greatest brilliancy in the evening sky. Although it will come closer as it swings between the earth and the sun, it is now in a waning crescent phase, which dims its brightness in our sky. The crescent shape is easily resolved in binoculars. This is a good time to find Venus in the daytime if you know its position relative to the sun.

March 2–3: The bright object near the moon is Saturn.

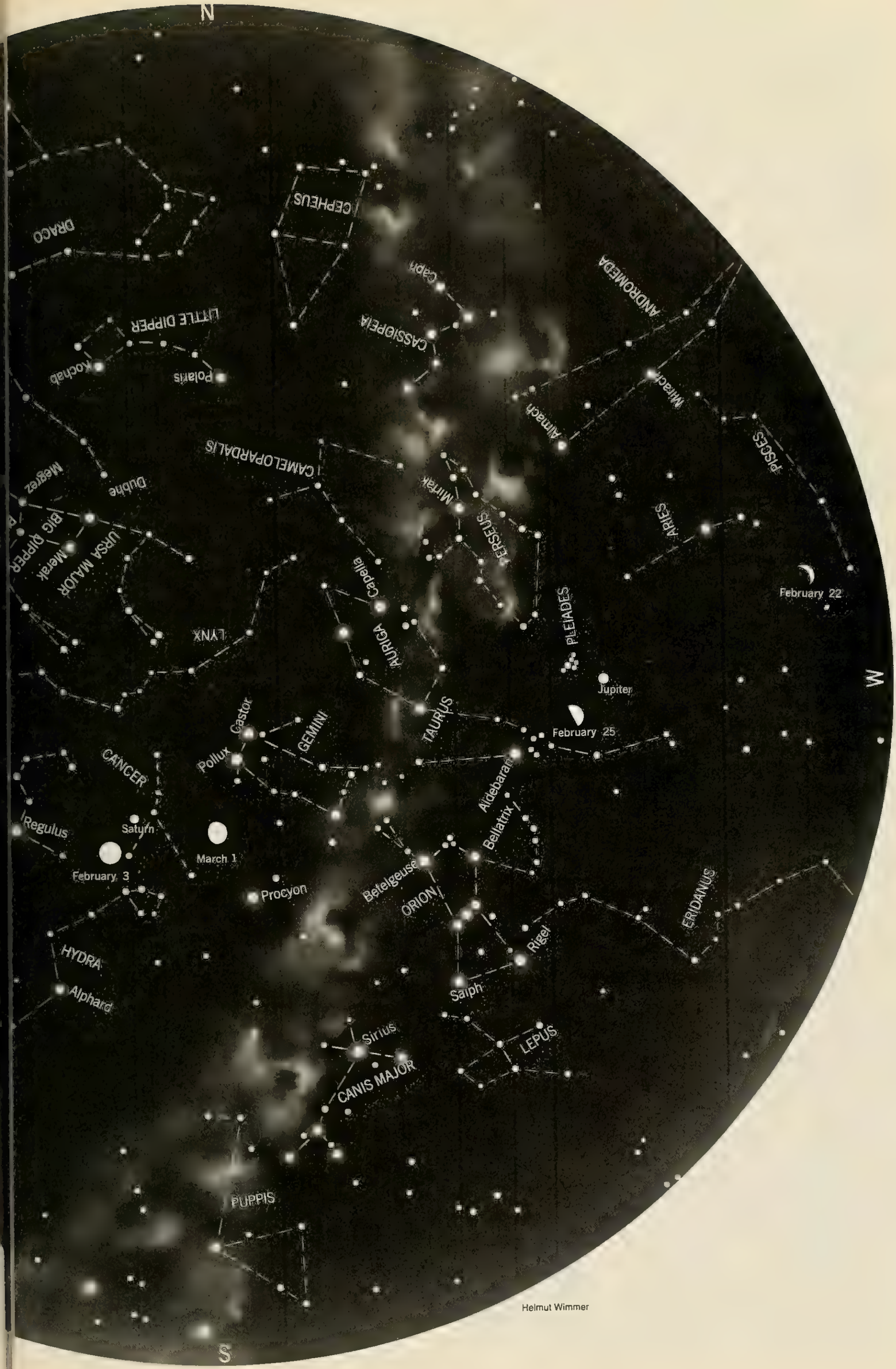
March 8: The moon is nearest the earth.

March 14: Venus begins its retrograde (westerly) movement, taking it rapidly closer to the sun as it swings in between the earth and the sun.

March 15: Mercury is in line with the sun and beyond it (superior conjunction) and enters the evening sky.



★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:10 P.M. on February 1; 10:15 P.M. on February 15; 9:25 P.M. on Feburary 28; and 8:25 P.M. on March 15; but it can be used for an hour before and after those times.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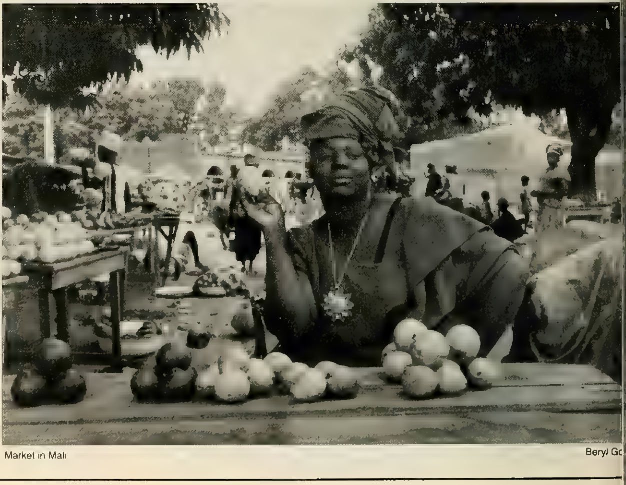

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Announcements

On February 13 Margaret Mead, curator emeritus of ethnology at The American Museum, will lecture on **Keeping in Step with the Future**. Unlike previous generations, ours is privileged in knowing a great deal about the future into which we are moving. Mead will discuss the kind of communication necessary to facilitate both our own participation and that of our children and grandchildren in this transition. She will also talk about the generation gap, focusing on the communication bridges necessary for three generations to experience the tremendous changes taking place in the contemporary world. The lecture will be held in the Museum's main auditorium at 3:00 P. M. Admission will be $5.50 for the general public and $4.50 for Museum Participating Members (limit of two). Tickets available by mail or at the Museum Members Lounge. For further information, call (212) 581-1810.

The first lecture in the Museum's **Evening Lecture Series for Adults** will begin on February 8. Nine different series will include such subjects as underwater archeology, weaving, medical entomology, the world of mammals, and a tour of the Hall of Minerals and Gems. Two of the series will be on anthropological subjects. In one, Malcolm Arth, chairman of the Department of Education, discusses his field work experiences in both a west African village and in a native American village. In the other, Paul J. Sanfacon, Museum lecturer in anthropology, will synthesize present-day thinking of anthropologists concerning both tribal and modern societies. Another series entitled "The Grand Delusion" will discuss rumors and myths, ranging from Atlantis to alchemy, that still haunt twentieth-century science. Each series includes between two and ten lectures, one each week. Prices range from $10 to $60. For further information regarding enrollment, cost, and time call (212) 873-7507.

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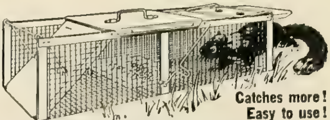

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by Alvin M. Josephy,

A Sojourn Among the Indians

People of the First Man, edited by Davis Thomas and Karin Ronnefeldt. *E.P. Dutton & Co., $29.95; 256 pp., illus.*

In the spate of outsize, sumptuous coffee table books with dramatically designed jackets and catchy titles that come tumbling out from publishers, it is sometimes easy to overlook one that is really a significant event. Especially is this true when in these days of many handsome picture books on American Indians the volume appears to be simply another one with a different title.

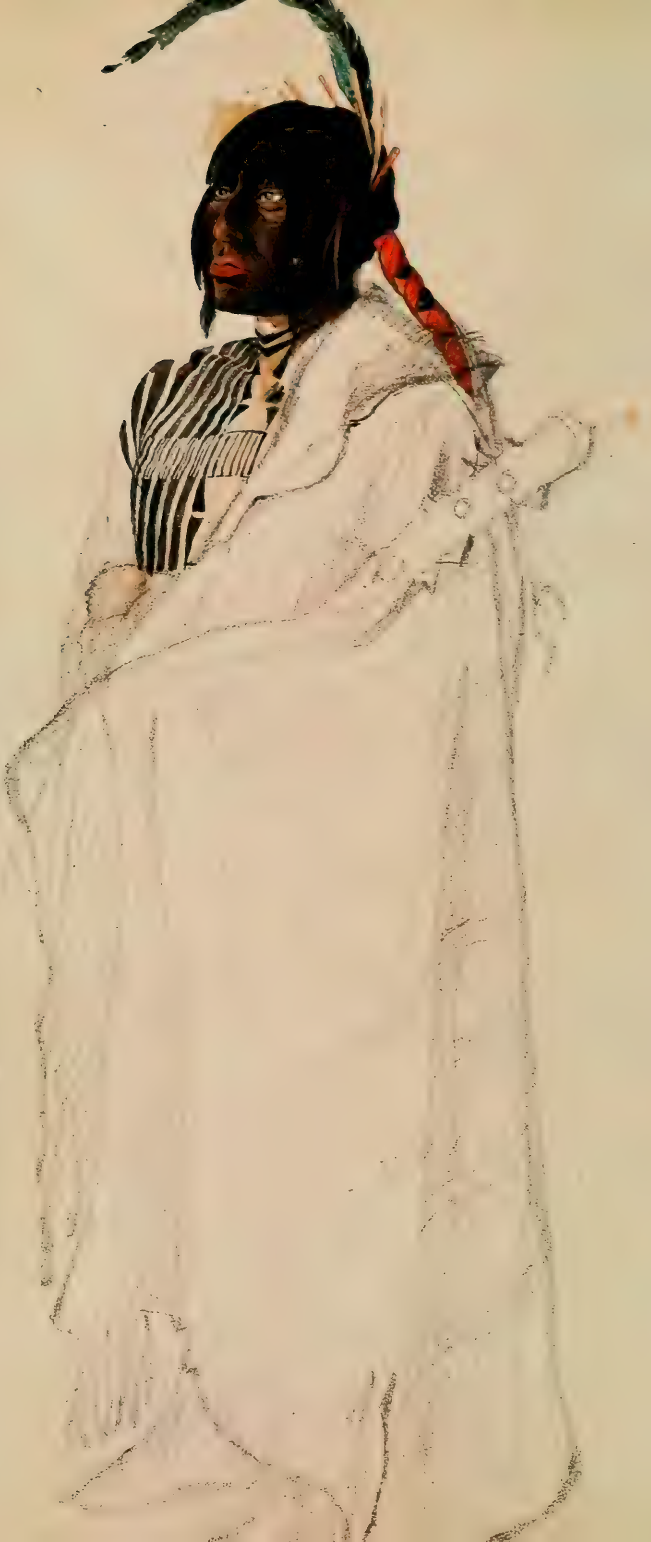
Ah, but this one *is* different, and don't miss it, for it is the long-awaited first publication of a large and representative sampling of the original watercolors and sketches of the almost-legendary Swiss artist Karl Bodmer, whose pictorial interpretations of Indians have never been surpassed. With enormous skill and attention to detail Bodmer painted individuals and scenes of life among a score of tribes on the upper Missouri River in 1833–34. His work, known chiefly for more than a hundred years only through 81 hand-colored aquatint engravings of his more than 400 paintings and drawings, has been recognized by ethnologists, historians, and others as the ablest and most accurate artistic representation of the American Indian—and has, during all those years, whetted their appetite to see the originals.

Bodmer, 24 years old at the time, went up the Missouri in the employ of a most remarkable European explorer-naturalist, Prince Alexander Philipp Maximilian of the Prussian principality of Wied-Neuwied near Coblenz on the Rhine. A veteran of the Napoleonic Wars, the 50-year-old Maximilian had earlier published a well-received book on his explorations and observations of the Indians of coastal Brazil and now wished to do another one on some of the tribes of North America. Accompanied by his personal retainer and hunter, a man with the unlikely name of David Dreidoppel, and by the youthful Bodmer, whose talented paintings had been brought to the prince's attention by a prominent Swiss zoologist, Maximilian arrived in Boston in July 1832. The following spring (Maximilian spent the winter in Indiana, while Bodmer went down the Mississippi to New Orleans, painting wherever he went), the three Europeans started up the Missouri River as passengers on a steamboat that carried supplies to the distant trading posts of the American Fur Company.

Maximilian was meticulous, committed, and with great talent of his own: an intelligent, trained observer and perceptive reporter of all that he saw and learned. The group eventually went all the way to Fort McKenzie, a crude fur post near present-day Great Falls, Montana, some 1,500 miles up the river, meeting tribe after tribe, which although already touched and changed by contact and trade with British, French, and American fur traders, were still free and at the height of the greatest days of the short-lived Plains Indian culture. As raw material for his book, Maximilian kept a detailed field journal, which reached a total of almost 500,000 words, and made sketches and drawings of his own. But his eye was also on Bodmer, whose pictures he planned would illustrate his bo
and he selected the subjects, prodd
the artist to paint individuals, la
scapes, and scenes about which
intended to write.

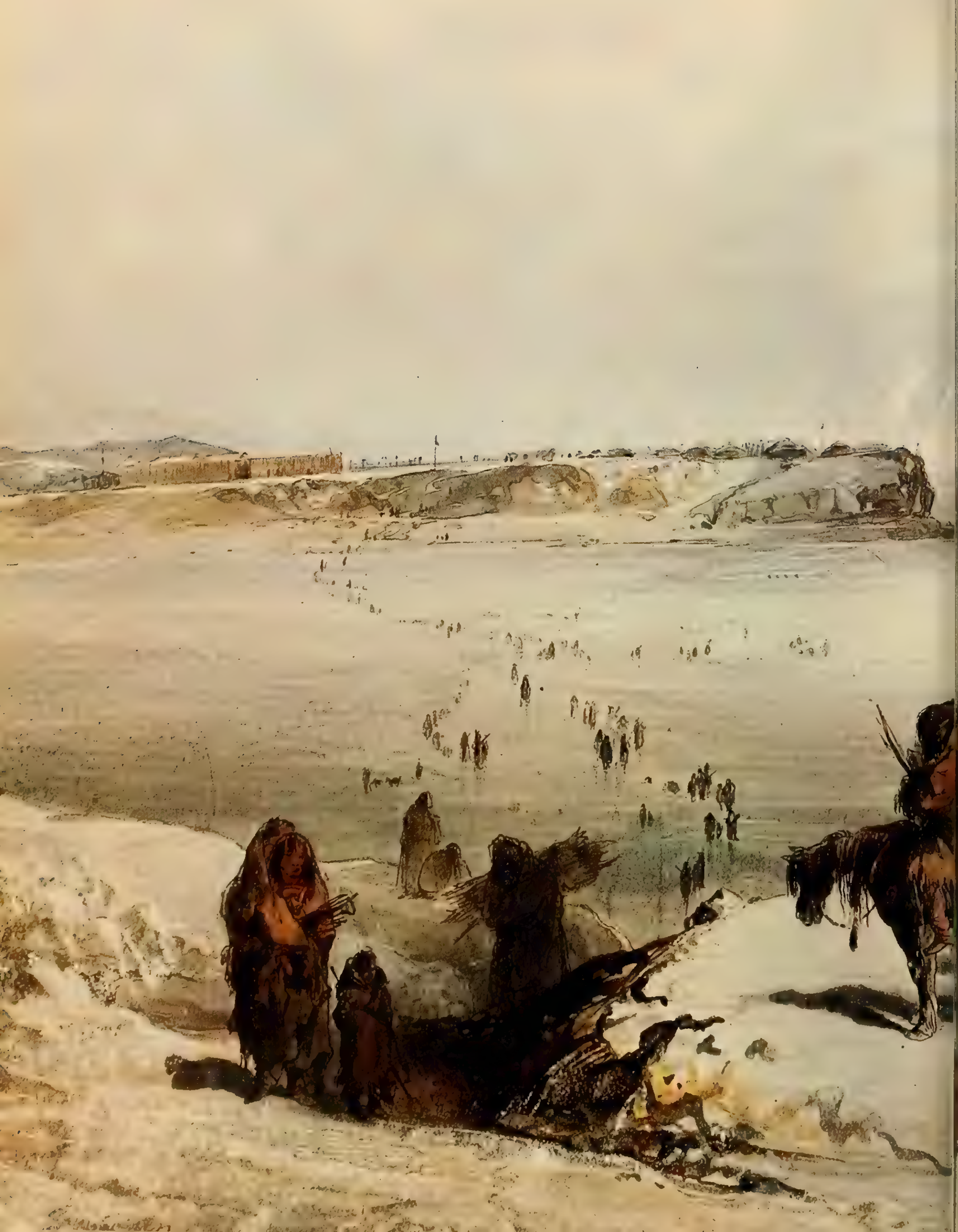
The trip ended in April 1834,
travelers returned to Europe,
from his journals Maximilian wro
narrative of almost 300,000 wo
which was published in Coblen
1839–41 and reprinted in both Fre
and English. Filled with fascina
detail on natural history, geograp
and the fur trade, as well as on
life and customs of the Indians,
book was the fullest and most imp
tant account of that part of N
America—still far beyond the
settlements of civilization—since
publication of Lewis and Cla
Journals some thirty years bef
But it was the stunningly color
vivid copperplate engravings, m
from some of Bodmer's waterco
accompanying the book, that m
Maximilian's text vibrant and rea
his readers—and in the end eclip
the text, good as it was.

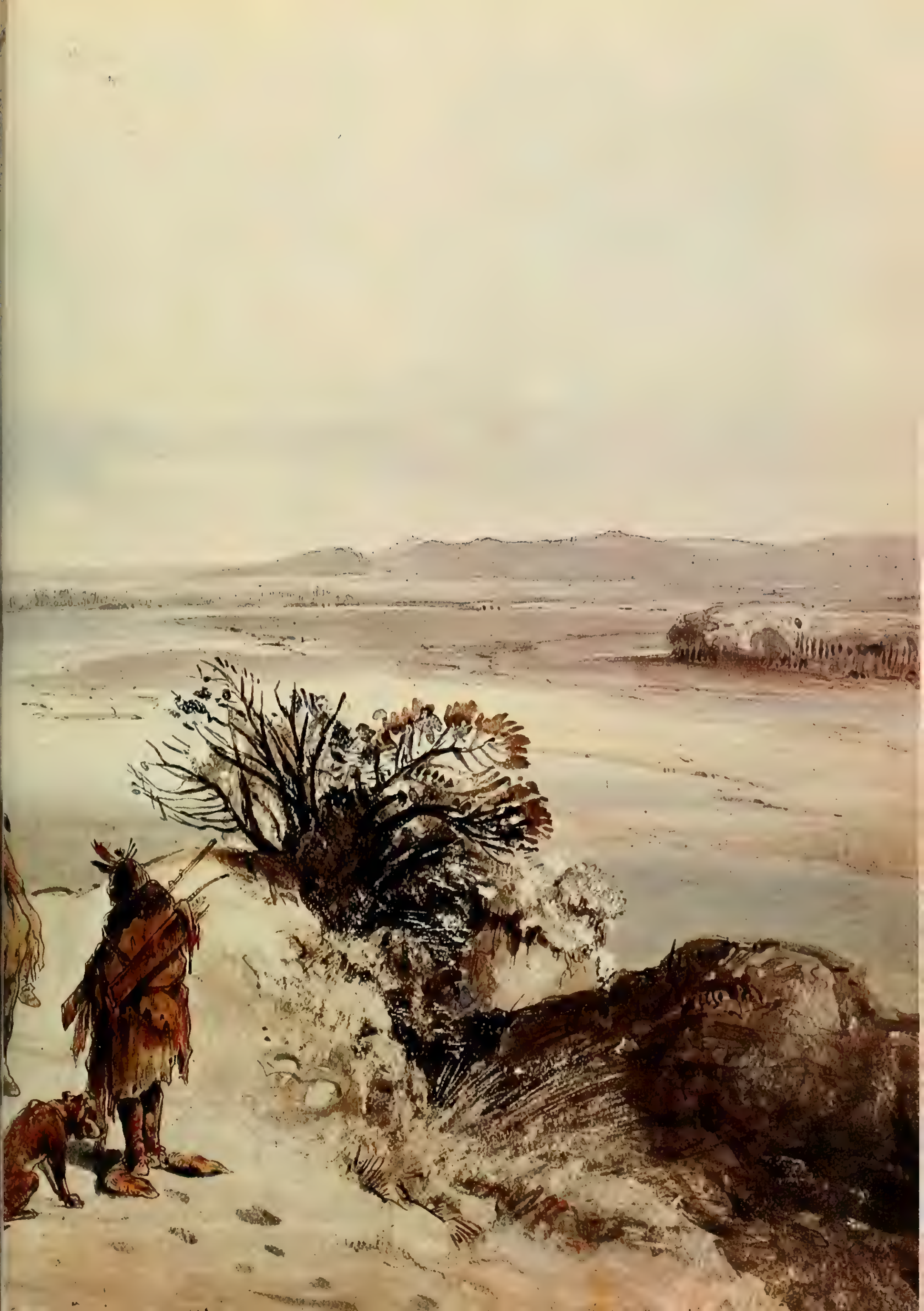
As to the original documentary m
terials—both Maximilian's jour
and Bodmer's watercolors—they
mained in the possession of the pri
and his family. The journals w
never published, and only from ti
to time would one or more
Bodmer's sketches or watercolors
reproduced, and then usually in a
alog or specialized publication.
the 1950s, interest in Bodmer's or
nal works heightened; then, foll
ing a traveling exhibition of 118
them in the United States under
auspices of the Smithsonian Inst
tion, the Northern Natural Gas Co
pany of Omaha, in an act of g

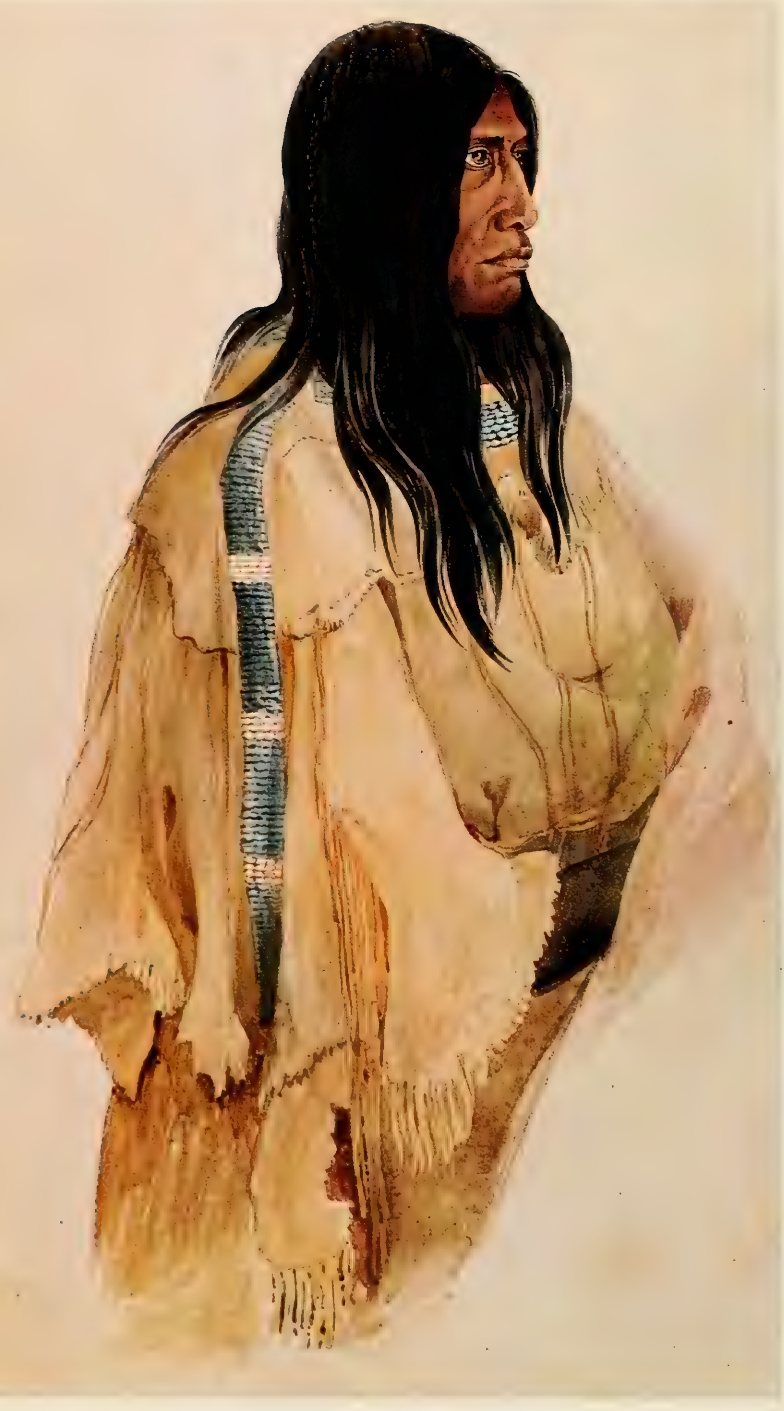


hsi-Nika, a
nute Mandan
ı, posed for
ıer with his face
ed black in honor of
ırt in the killing of
siniboin.

Fort Clark and the Mandan village of Mih-Tutta-Hang-Kush as seen from the eastern bank of the Missouri River.







Maximilian attributed this Snake Indian woman's dark complexion to a liver disorder.

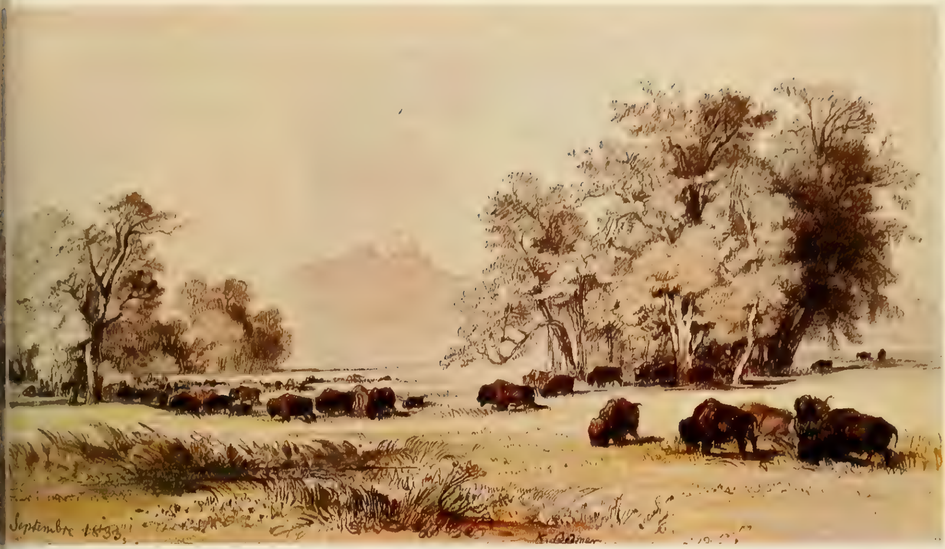
public service, purchased everyt
possible pertaining to the Max
ian-Bodmer expedition and book
placed the full collection of
prince's journals, notes, acc
books, traveling equipment,
other property, and all of Bodn
original watercolors and drawing
loan to the Joslyn Art Museu
Omaha for study and exhibition.

There then began a dedicated e
on the part of many people, mos
tably Mildred Goosman, the
seum's curator of western co
tions, to get the material publis
The difficult German handwritin
the prince's original field jou
was laboriously translated into
lish, but because of the huge co
reproducing Bodmer's several
dred watercolors and printing a 5
000-word text that would ap
(though importantly) mainly to
thropologists, historians, and
specialists, no publisher was ab
take on the task.

The present volume (for w
thanks must go to the persistence
obvious enthusiasm of the two ed
and Goosman, who provides a pa
and knowledgeable introductio
something of a compromise.
great glories of many of Bodm
originals, a small number of w
did get into print in a special port
in *American Heritage* magazin
April 1963, are there, bringing o
far greater realism and detail tha
old hand-colored engravings,
landscapes and scenes of the
Missouri, the tableaux of camps
forts, and the dress, equipment,
features of the warriors, ch
women, and children of Assinib
Blackfoot, Sioux, Mandan, and
Plains tribes. There is enough
cisely recorded ethnological and
torical material in these origina
keep students (and all the rest o
busy and happy for a long time.

But there is a shortfall. Only 7
Bodmer's paintings are reproduce
color. Another 48 are printed in b
and white, along with 27 orig
black-and-white sketches or eng
ings. This is out of a total of n
than 400 of Bodmer's works
were available. Chalk it up to the
nomics forced on the publisher.

At the same time, specialists
be disappointed because the boo
limited to the trip up the Misso
omitting text and pictures relatin
the many months the travelers s
in other parts of the United S
and, more importantly, because



er sketched this herd of buffalo in the Mauvaises Terres.

ive text used by the editors is osed mainly of excerpts from rince's published book (in- ersed here and there with their expository material) and con- only tantalizing bits from the olished but more graphic and diate field journals. These bits, s they are, provide some pre- ly unknown information on the ade and other matters and sug- that there is considerable new ial for historians and anthro- ists embedded in the still-un- shed journals. Again, however, ust accept the editors' need for and clarity within the limits im- l on them by this volume. They selves, indeed, note that their annot be used for purposes of s scholarship.

t count our blessings, as Goos- as done. Unable to include ev- ing, she and the editors have eded in producing a radiant, larly oriented book that will Maximilian and Bodmer to a general audience, an important tep. Now, perhaps, the National wment for the Humanities, a te foundation, or some other actor will see the wisdom of ng to underwrite the ultimate and make the publication of the Maximilian-Bodmer collection ity.

M. Josephy, Jr., is editor in of American Heritage's magazine division and the author of numerous articles and books on American Indians.

This publishing season has been graced with a number of fine books on the American Indian:

WIND ON THE BUFFALO GRASS, collected and edited by Leslie Tillett. *Thomas Y. Crowell Company, $35.00; 158 pp., illus.*

Subtitled *The Indians' Own Account of the Battle at the Little Big Horn River and The Death of Their Life on the Plains,* it is just that—the incidents made more vivid by the use of Indian drawings and paintings. The numerous firsthand accounts of the actual battle and its terrible aftermath will perhaps lay to rest the flamboyant "popular" versions of the tragedy and give the Indians an active voice in their own history.

SONG FROM THE EARTH, by Jamake Highwater. *New York Graphic Society, $19.95; 212 pp., illus.*

This is the first work for the general reader on American Indian painting. Highwater does an admirable job of presenting the Indian viewpoint and provides a framework on which to build an understanding of Indian painting and art objects. From pre-Columbian art through the vibrant work of twentieth-century artists, Highwater traces what is both universal and uniquely "Indian" in American Indian painting. A very helpful directory of collections of Indian paintings, a chronology, and a bibliography are provided at the end of the book.

THE NAMES, by N. Scott Momaday. *Harper & Row, $10.00; 170 pp., illus.*

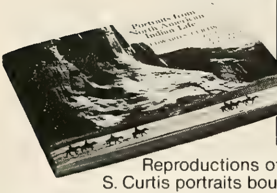
Momaday, the Pulitzer Prize-winning novelist, has written an autobiographical account of his Kiowa upbringing on Indian reservations in the Southwest. Using tales he was told as a child, his memory, and his imagination, Momaday re-creates the forces that shaped his heritage. Scattered throughout the book are wonderful old family album photographs.

EDWARD SHERIFF CURTIS: VISIONS OF A VANISHING RACE, text by Florence Curtis Graybill and Victor Boesen. *Thomas Y. Crowell Company, $35.00; 303 pp., illus.*

Edward Curtis was a turn-of-the-century society photographer who was devoted to producing an illustrated history of the native tribes of North America. This book, one of several dealing with Curtis that have appeared in recent years, adds new information culled from his writings and correspondence and the recollections of his daughter Florence Graybill. More than 175 of his photographs are reproduced. The portfolio section of the book, made up mainly of portraits, is a dazzling display of this gifted man's work.

Carol Breslin

Portraits
from
North American
Indian Life
by
Edward S. Curtis



Reproductions of 88 memorable photogravure prints of Edward S. Curtis portraits bound together into a book, incorporating many of the best specimens of his "loving and poetic monument" to the North American Indian. Fascinating captions describe each Indian life study, composed from Curtis' own personal impressions, his notes and field records. Insightful introductions by A.D. Coleman and T.C. McLuhan. 12" x 9", soft cover. $8.50, covers shipping and handling.

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Additional Reading

Indian Rock Art (p. 42)

In *The Archaeology of North Am*
(New York: Viking Press, 1976),
fusely illustrated with black-and-v
and color photographs, Dean R. S
provides archeological evidence fo
pervasive influence of shamanism a
prehistoric North America. Mi
Eliade's *Shamanism: Archaic T*
niques of Ecstasy (repr. Prince
Princeton University Press, 1964, $4
is a discussion of the cross-cultural n
of this phenomenon. A special do
size issue of *artscanada* (Decer
1973/January 1974), entitled *Sto*
Bones and Skin, is devoted to six
essays on shamanic art; see, in partic
Peter Furst's "The Roots and Conti
ties of Shamanism" (pp. 36–60) and
Vastokas's "Shamanic Tree of L
(pp. 125–49). In their well-illustr
book, *Sacred Art of the Algonkian*
Study of the Peterborough Petrogl
(Peterborough: Mansard Press, 19
anthropologists Joan and Romas
tokas interpret the shamanistic char
of a group of Canadian rock carvings
ilar to those found in Maine. Camp
Grant, a historian of aboriginal art, in
tories known North American p
glyphic and pictographic sites in
Art of the American Indian (repr.
York: Apollo Editions, 1972, $2.95
"California's Legacy of Indian F
Art" (*Natural History*, June-July 1
pp. 31–41), Grant compares the sig
cance of these prehistoric native An
can carvings and drawings with the w
known cave paintings of France
Spain; see, for example, "Ice Age
mals of the Lascaux Cave," by De
Perkins, Jr. (*Natural History*, A
1976, pp. 62–69).

Shotgun Houses (p. 50)

Anthropologist Melville J. Hersko
founder of the first American unive
program in African studies, has wri
a number of books detailing how
World ways survive in the accultura
situation. A central theme of his 1
treatise, *The Myth of the Negro*
(repr. Boston: Beacon Press, 19
$2.95), is the positive aspect of muc
America's African heritage; *Life i*
Haitian Valley (Garden City: Dou
day, 1971, $2.50) treats similar facet
village life among the descendants
slaves on one Caribbean island. Ju

Chase, curator of The Old Slave
luseum in Charleston, South Caro-
aces the acculturative experience
-*American Art and Craft* (New
Van Nostrand Reinhold, 1971,
). Concentrating on artifacts of
Georgia and South Carolina, Rob-
is Thompson's study of the "Afri-
fluence on the Art of the United
" (pp. 128–77), in *Black Studies in*
iversity, edited by Armstead L.
on et al. (New Haven: Yale Uni-
Press, 1969, $2.45), surveys the
l of Afro-American esthetics in
, wood carving, graveyard sculp-
nd other folk art. John Michael
s "Phillip Simmons: Afro-Ameri-
acksmith," in *Black People and*
Culture: Selected Writings from
rican Diaspora, edited by Linn
o (Washington: Smithsonian Insti-
Press, 1976, pp. 35–58), describes
ican traditions seen in the craft of
t Charleston blacksmith. Vlach's
hotgun House: An African Archi-
l Legacy" (*Pioneer America,*
vol. 8, pp. 47–70) provides addi-
details of his research. *New Or-*
Architecture, vol. 4, *The Creole*
urgs, edited by architectural histo-
am Wilson et al. (Gretna: Pelican
hing, 1974), a series of essays on
le of blacks in that city's archi-
, is beautifully illustrated with
and present-day photographs and
gs of shotgun houses.

gered Fish (p. 64)

Ecology of Man: An Ecosystem
ach, edited by Robert L. Smith and
le in paperback (New York:
& Row, 1976), is an illustrated
ion of articles on the reciprocal re-
hip between man's activities and
osystem; for example, Harry M.
l's "Energy, Environment, and
traction of Minerals" (pp. 260–61)
ses the production of "endangered
nments." Caudill is also the author
ght Comes to the Cumberlands
n: Little, Brown and Company,
$2.95), a classic description of the
ation wrought by strip mining in
cky's mountains. Branley Allan
n's "Stripping the Appalachians"
al History, November 1974, pp.
) explores mining activities from a
ist's viewpoint. Siltation as a direct
irect cause of the elimination of fishes is examined in "Effects of Strip Mining on Small-Stream Fishes in East-Central Kentucky," by Branson and Donald L. Batch (*Proceedings of the Biological Society of Washington,* 1972, vol. 84, pp. 507–18). "Acid Rock in the Great Smokies: Unanticipated Impact on Aquatic Biota of Road Construction in Regions of Sulfide Mineralization," by John W. Huckabee et al. (*Transactions of the American Fisheries Society,* 1975, vol. 104, pp. 677–84), explores another source of pollution. That yet a third source is not unique to Kentucky is illustrated by Peter B. Moyle's "Some Effects of Channelization on the Fishes and Invertebrates of Rush Creek, Modoc County, California" (*California Fish and Game,* 1976, vol. 62, pp. 179–86). For background to these problems see R. R. Curry's "Rivers: A Geomorphic and Chemical Overview" (pp. 9–31), in *River Ecology and Man,* edited by Ray T. Oglesby et al. (New York: Academic Press, 1972, $16). Historian Thomas D. Clark's *The Kentucky* (Lexington: Henry Clay Press, 1969, $7.95) is a discussion of the past and present status of that state's chief river.

Peter Pitseolak (p. 70)

People from Our Side, a life story with photographs by Peter Pitseolak and oral biography by Dorothy Eber (Edmonton: Hurtig Publishers, 1975, $8.99), and *Pitseolak: Pictures Out of My Life,* from recorded interviews by Dorothy Eber (Seattle: University of Washington Press, 1972, $9.95), are unique accounts of the changing Eskimo culture. The first documents the transition through the lens of an Eskimo's camera; the second through the remarkable graphic art of an Eskimo woman. William T. Larmour's *Inunnit: The Art of the Canadian Eskimo* (Ottawa: Queen's Printer, 1968, $3.25) and George Swinton's "Arctic Renaissance" (*Natural History,* January 1973, pp. 64–71) describe and illustrate the Eskimo art forms that have emerged as one of the results of the acculturative process. Edmund Carpenter's *Eskimo Realities* (New York: Holt, Rinehart and Winston, 1973, $12.50) provides an incisive anthropological assessment of the disappearance of the "old ways." In *Seasons of the Eskimo: A Vanishing Way of Life* (New York: New York Graphic Society, 1971, $17.50), Fred Bruemmer's emotionally powerful photographs and sensitive text focus on the rapidly changing culture and environment of the Arctic. Anthropologist Nelson Graburn's *Eskimos Without Igloos* (Boston: Little, Brown and Company, 1969, $3.95) is a study of the impact of social and economic development on the people of North America's last frontier. *Eskimo Songs and Stories,* translated by Edward Field, with illustrations by Kiakshuk and Pudlo (New York: Delacorte Press, 1973, $6.95), offers insights to Eskimo life through their folklore, as do a number of fictionalized sagas drawn from Eskimo tradition: James Houston's *The White Dawn* (New York: Harcourt Brace Jovanovich, 1971, $8.50) and Farley Mowat's *The Snow Walker* (Boston: Little, Brown and Company, 1975, $8.95).

Tsetse and Trypanosomes (p. 76)

Man Against Tsetse: Struggle for Africa, by John J. McKelvey, Jr., (Ithaca: Cornell University Press, 1973, $12.50), is a popular account of the discovery and epidemiology of trypanosomiasis in Africa, detailing the impact of the disease on the continent and its people. British entomologist John Ford has worked in east Africa on problems associated with the insect vector of trypanosomes; his book, *The Role of Trypanosomiases in African Ecology* (Oxford: Clarendon Press, 1971), deals with the ecological requirements of the tsetse and the influence of this vector on the disease's epidemiology. *The African Trypanosomiases,* edited by Hugh W. Mulligan (New York: Halsted Press, 1970), with more than twenty chapters on trypanosome biology, presents information on such aspects as immunological reactions of host species and methods of treatment. "Ecological Effect of Control of African Trypanosomiasis," by W. E. Ormerod (*Science,* 1976, vol. 191, pp. 815–21), discusses the possible links between trypanosomiasis, the cattle industry in western Africa, and recent droughts in the Sahel. Although dealing with the control of malaria, Robert S. Desowitz's "How the Wise Men Brought Malaria to Africa" (*Natural History,* October 1976, pp. 36–44) presents a strong case for the interplay of economic development and the spread and control of disease in tropical Africa.

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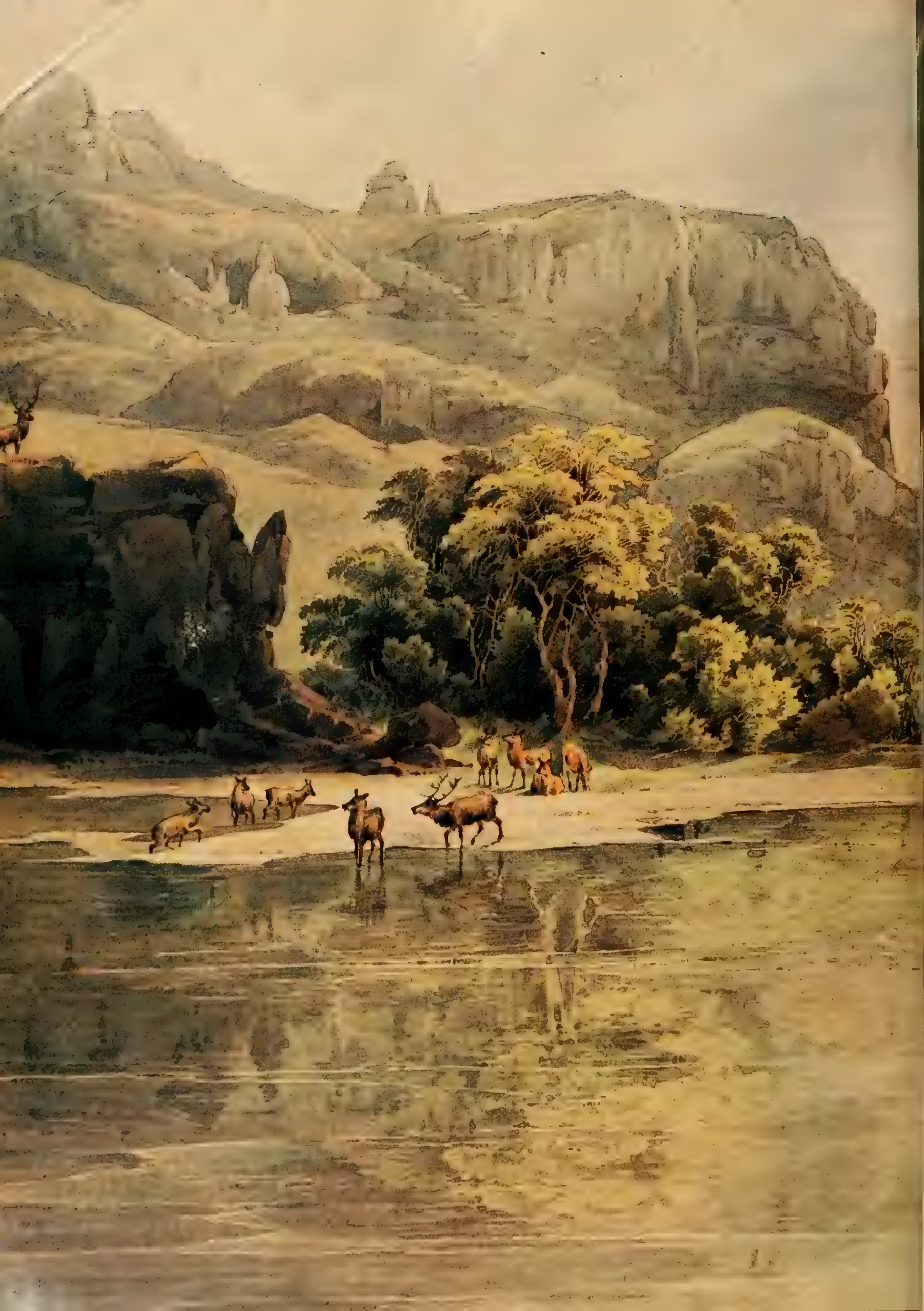

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MARCH 1977 • $1.25

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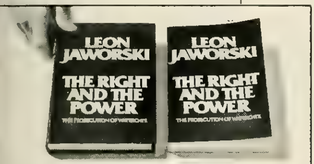

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Authors

Editor of a weekly newspaper in Durango, Colorado, **Rodney Barker** became interested in whooping cranes because as an endangered species they "go right to the root of man's careless use of his resources." Barker is now photographing geologic formations in the Four Corners area of the Southwest as a free-lance project. His next self-imposed assignment will be to probe into the Old West Regional Commission's efforts to implement economic development programs for regional native Americans. When not working, Barker seeks the life-giving properties of the mountains and desert.

On leave from the University of Michigan, where he is an associate professor of geography, **Bernard Nietschmann** is in Australia on a grant from the National Geographic Society. A frequent contributor to *Natural History,* and its newest columnist, Nietschmann is studying interrelationships between dugong and sea turtle behavior, and also hunting patterns and cultural adaptations among Torres Strait Islanders. A senior research fellow at Australian National University, he will be down under until July. A veteran of numerous expeditions to Central America, Nietschmann has a book in progress on his often bizarre field experiences with the Miskito Indians of eastern Nicaragua (*see* "The Nicaraguan Skin Connection" in the January 1977 issue). This month's column is his first from Australia.

During an Air Force stint,
neth E. Glander was assigne
task of caring for monkeys use
experimental purposes. Now t
ing anthropology at Duke Unive
he is five years into a twenty
project investigating the socia
ganization and ecology of ho
monkeys. In the near future he
to expand his research to includ
feeding behavior of howling, sp
and capuchin monkeys to deter
the difference in feeding selec
among the species. As a sideli
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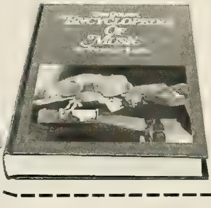

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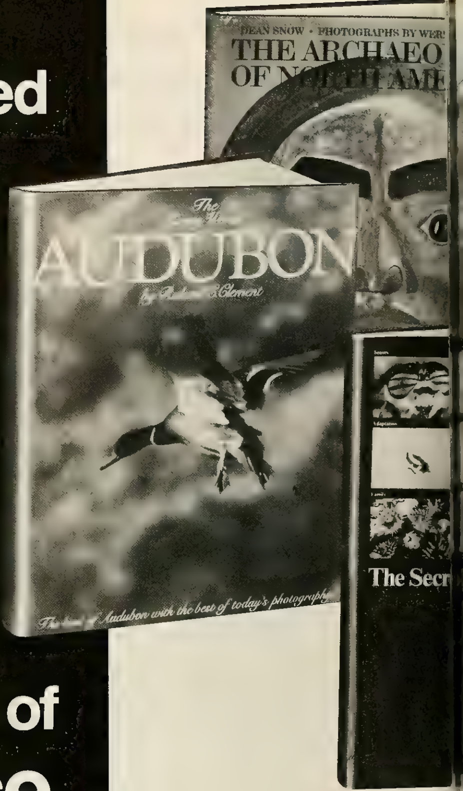
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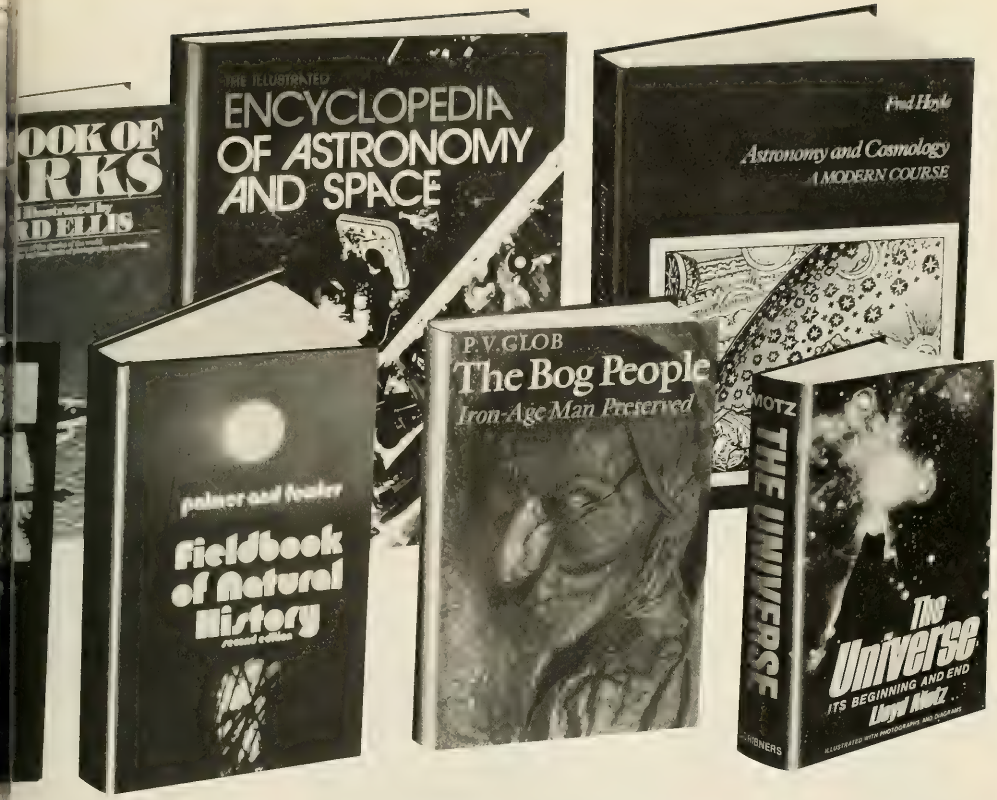

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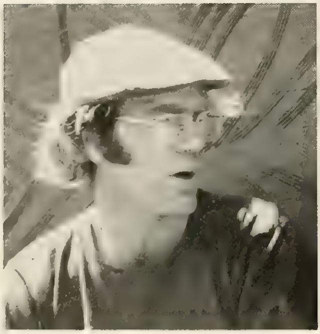
Founder and director of the Goddard Institute for Space Studies in New York City, **Robert Jastrow** began his career as a nuclear physicist. In 1958 he joined the newly established National Aeronautics and Space Administration as head of its theoretical division, which is responsible for conducting basic research in astronomy and the planetary sciences. In addition to his administrative duties, Jastrow is an adjunct professor of geological science at Columbia University and of earth science at Dartmouth College. Writing is his hobby, he says. He is the author of *Red Giants and White Dwarfs*, an astronomy book for laymen, coauthor of an astronomy textbook, and has written many magazine articles. A new book, *Until the Sun Dies*, from which his current article was adapted, will be published this year.

An intrepid investigator of Arctic life, writer-photographer **Fred Bruemmer** had more than his usual share of hard knocks on his expedition to Little Diomede Island in the Bering Strait. He reports: "The trip didn't start too well. On my first flight to the island, the plane crashed into a mountainside and was a total loss. On Diomede, my reception was somewhat cold. Gradually the islanders got used to my presence and took me along on their hunting trips, provided I did my share of the work. Being able to interpret between them and visiting Eskimo from Siberia, via Russian and English, helped me fit into village life and overcome the Diomeders' initial aloofness." Bruemmer's last article for *Natural History*, "A Year in the Life of a Harp Seal," was published in the April 1975 issue.



George F. Rohrmann is a postdoctoral fellow in biochemistry at Oregon State University. His work is concentrated on viruses that are being considered for use as a biological control for the larvae of the Douglas fir tussock moth. It was while serving as a senior lecturer in the Department of Biology of the University of Botswana, Lesotho and Swaziland from 1970 to 1975, that Rohrmann did the field work for his article on mantids. Because they were conspicuous and photogenic, he kept several mantids as pets.

When **Peter T. Furst** and **Mi**
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Maya vase in a private collectio
years ago, they realized they
seeing a representation of a l
known aspect of Maya culture
years, the poses and position
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gists. The vase, showing the N
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cheology. A professor of ant
pology at the State University of
York at Albany, Furst has stu
pre-Columbian art and iconogr
in Mexico and Guatemala for r
than fifteen years. Coe, who tea
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researching aspects of Maya
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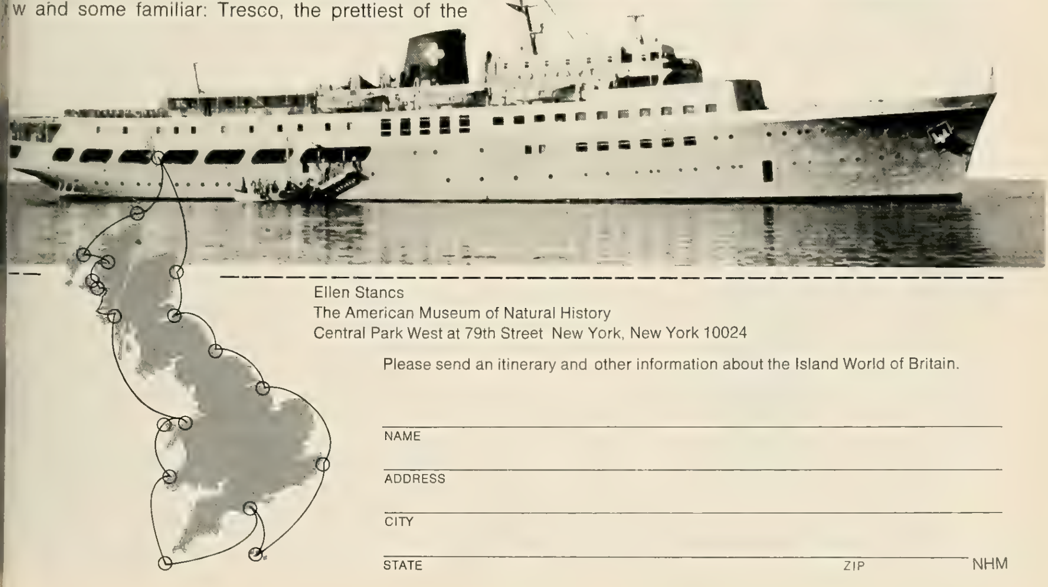

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The Wind Caller

In a native Australian village, a curious American scientist played along with the elder's whims. Then the game got deadly serious

Coming out of the Coral Sea, a branch of the South Subtropical Current sets west. Driven by the trade winds and deflected by the Great Barrier Reef, the current turns northwest and spills through the channels and over the wide coral shoals at the northern flanks of the reef. Into the deepwater passages of Yule, Flinders, and Bligh Entrances and through the Torres Strait, the current flows west: around the volcanic islands of Murray, Darnley, and Stephens; past the jumbled outcrop of black rocks and wind- and surf-piled coral sand known as Bramble Cay, where green turtles seasonally congregate to nest on isolated shores; across the Darnley Deep where pearl shell divers descended to depths where day became night and the water tugged so awesomely that they flapped like flags in the liquid wind.

West into the "archipelago of Islands without number," which Juan Torres first described in 1606, and which subsequent captains and crews came to dread for the chance of shipwreck in the reef-strewn waters and the island inhabitants' practice of killing survivors. West into the water hourglass, the double funnel that separates New Guinea from Cape York Peninsula and joins the Coral and Arafura seas, of which Matthew Flinders wrote: "Perhaps no space of 3½° in length represents more dangers than Torres' Strait." But Cook and Bligh passed safely through and their charts traced channels that others could follow.

Far perimeter of the strait. Wind- and tidal-stream-aided current pours through narrow confining passages in the reefs and toward the multitude of small and large Western Islands; surges into Endeavour Strait. Past Horn Island with its refurbished airfield and its memories of scattered bombing by Japanese planes during World War II; past tiny Thursday Island and its remnant fleet of five pearl luggers, its four crowded hotel pubs and beaches littered with broken beer bottles; past rugged Moa and Badu islands; past the rich dugong and sea turtle grounds of Orman Reef; and past Australia's northernmost border, the mangrove-lined islands of Boigu and Saibai, low and muddied in New Guinea river outwash, and Dauan, the pretty, cone-shaped, high-rising island. Westward toward uninhabited Deliverance, Kerr, and Turu islands, and Booby Island with its forlorn box, simply labeled "Post Office," placed there in 1835 as a mail drop for ships on their way to London and Sydney.

Flood tide and current setting west into the Arafura, where it is full fathom twenty and more; reefs and island shoals disappearing beneath the rising tide.

"Tide coming up now. Strong. See, that's new moon quarter tide, run straight, just like I tell you. *Kulis* going down to the west. Everything in the sea change over, turtle, dugong, fish—everything on tide."

Gelam and I stood on the warming white sand beach, watching the tide come in. *Kulis*, the east to west trade wind time flood tide, lapped at the bottom edge of his red lavalava as he bent over to pick up something from the advancing water. "Dugong been eating on *kulis*, lee side of reef," he said with confidence, pointing to the fragment of leaf blade he held in his hand.

I wanted to know how he had deduced that a dugong was feeding ing flood tide, in a specific reef z all from a two-inch-long clue.

"Look that torn edge, dugong on *kulis*, can't hold proper stead bottom, rip that grass. When s tide time, or *gutat* tide [west to ebb tide], going down, then grass proper straight across. Good to l then; good for you to take pic then, too."

Gelam was a good field natura Little escaped his attention and took pride in his knowledge of ti currents, winds, stars, and the as ciated behavior and movements marine life. At 62 he was old eno to have learned much from "b time people" and their practical conceptual understanding of sea sky island worlds, and he maintai a pragmatic disdain for "these m ern times." He never missed a cha to comment on the younger gene tion's "back over front, messed ways," but he seldom missed a Ra Australia evening newscast, eith "Things going to the bad, not l before time," he would often s "Our ways changing." As much possible he lived beyond the eve day problems that a purchased ec omy brings to a traditional socie His true delight was natural hist and he radiated an infectious exub ance in his continuing pursuit to le more about the natural world and verify the old principles learned a boy.

Gelam had asked me to meet h on the beach that morning so that could prove to me that he could "c the wind." I didn't have much fa that he could, despite his assuran and knowledge of "island me cine," but I had come anyw Gelam had taken it upon himself instruct me about "island ways" a "proper knowledge" and we wer

by Bernard Nietschmann

le of weeks into what seemed to crash course. I think he thought little slow and thick headed be- e I didn't readily accept all that ld me. Maybe that's why he had eased the pace. Or maybe I was only one around who would at t listen.

When the tide catch that mark, d will come around," Gelam , indicating with a dexterous big the scratch mark he had made in sand with a tree branch the night re. I had been there then as well he showed me how to call the d. "Take small branch of *gabudel* , the one I get from old chiefs' e, strike him on sand, then point where you want wind to come. st call for wind in deep language, this gammon half and half they k today." He had called for a h wind for the next day.

Ve sat and waited while the tide e up, pushing before it small es of sea debris, each wave cov- g a bit more of the dugong and le bones left from numerous herings and randomly scattered r the intertidal area. Gelam pulled a round tin of Capstan Ready bed Tobacco, which he kept se- ed somewhere in his lavalava, rolled a cigarette. Head bent to atch, a muffled "no fear, soon e" leaked from cupped hands.

anxiously watched every advance hat tide as it moved up the beach ard the mark. There was little else o as Gelam had become silent. He n't look at the mark but watched clouds.

Kulis covered the mark and kept ng. I had my compass and was fac- into the southeast, pointing my e directly upwind so that I could the breeze on both my ears. So no change. I looked at Gelam and e him a palms up "what hap-

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pened?" gesture. He ignored me and watched the sky. We sat in silence for about fifteen minutes more, waiting. Abruptly, Gelam stood up, faced south for a moment, then turned to me and grinned. "Wind going around now, changing to the south."

He was right. It was a gradual change, nothing quick: the wind just started blowing in puffs and then burst from the south. It took more than an hour before I would really call it a south wind. Gelam knew where south was, but he watched the compass with me. South it was.

Feet spread in a seaman's stance, he said, "You believe me now?"

The wind change confirmed for Gelam that his "action" was still good and that the old ways still worked. I was positive about the wind change but still dubious that Gelam had caused it. According to the weather records I had copied, the Southeast Trades, after months of blowing in a steady direction, were due for change. Besides, he could have heard it on the radio the night before. It could have been any number of things—Gelam was always watching the clouds, listening for particular birds to sing out, even carefully observing the behavior of his two young pigs for signals of weather changes.

I was hesitant to tell him that I didn't believe he had called the wind, despite what I had witnessed. Besides, I was interested in dugongs and sea turtles and was beginning to wonder what I was doing on the beach with Gelam in the first place. Apart from our mutual interests, our conceptual outlooks differed drastically. I guess I am just easily distracted, and Gelam was, after all, a pretty engaging fellow. I wanted to get back to work, to get back on the reefs. The filter in the air compressor needed to be changed; the scuba tanks refilled. I was a couple of days behind on my notes—there were so many other things I could or should be doing, rather than watching the tide come up and waiting for the wind to change.

"*Ate,*" I began, referring to Gelam as grandfather, "I can see that the wind changed and I don't know why it changed, but I'm not ready to say that you did it all." I expected him to be angry with me because of the time he had spent the previous night and this morning—he had other things to do, too—so I hoped that by implying that he may have had something to do with the wind change, he would be placated and my standards of scientific observation would be only slightly tarnished. Moreover, I wanted to get back to the field research.

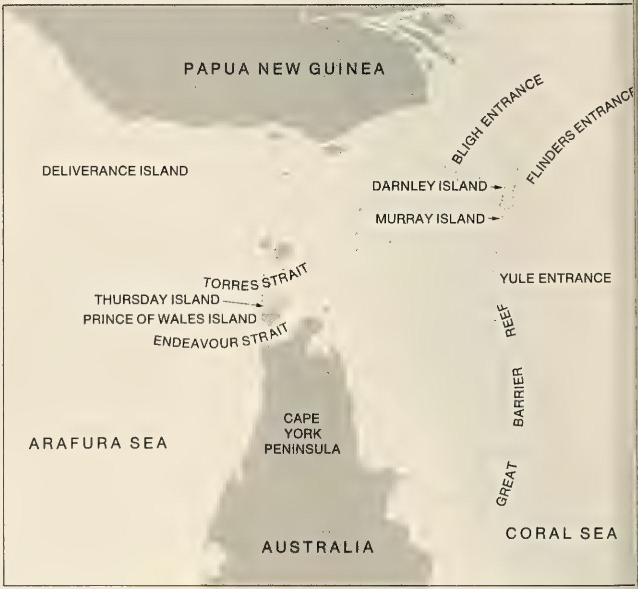
Gelam gave me a long, curious look, the kind that makes one want to check to see if there is a piece of mango stuck between one's front teeth. Then he began chuckling, a deep chuckle that started in his thick belly, worked up in ripples, and shook his body until the laughter just poured out. Gelam's sort of laughter sweeps everything before it, regardless of the circumstances. When someone laughs like that it's not important to know what's so funny, you just join in. We laughed together, tears running down our faces, until, gasping and choking, we wheezed to a stop for air.

When it was finally over and it was possible to breathe deeply again, Gelam turned and started back up the beach, motioning for me to follow. "Come," he said, "we've got more work to do on winds."

My wife, Judi, and I, along with our son, had come to Torres Strait to do a year-long research project on the behavior and ecology of dugongs and sea turtles. Unlike most other tropical shallow-water places in the world, these animals are still abundant here because Queensland State legislation limits their exploitation to Islanders and mainland Aborigines, and because there are relatively few Me
nesian Islanders, 2,500 or so, liv
in Torres Strait. After settling in
one of the Western Islands, kno
for its marine hunters and surroun
by huge, promising-looking reefs,
began our study.

We were especially interested
dugongs, but to study them you h
to find them. We would look at
tide tables, extrapolate time
height for our area, and make re
for a trip to the reefs—going thro
all the logistical hassles, such as g
ting gear ready and down to
beach—only to find that it was
low tide when we arrived there. R
drying; no dugong. This happened
frequently that I began to distrust
tide tables and my observations of
coming tides at the village beach
mean, you would think that if it w
a rising tide at the village and
tables confirmed this, that it wo
still be a rising, or high, tide f
miles away. But it wasn't always

I began to pay more attention to
tides. I noticed curious things: a hi
tide on one side of the island, a l
tide on the other; tidal streams t
dirtied the water in one spot, whil
quarter of a mile away the water w
clear; and days when entire ti
cycles would be missing—it wo
be high tide or low tide all day lo
To find out about dugongs, I w
going to have to learn much m
about the complicated and apparen



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Great Ships of British Registry since 1840 variable tides. Momentarily stymied and anxious to get on with the work, I sought out local help, never suspecting that the information I needed would be cemented in such a dense cultural conglomerate.

"What's the matter you come?" the old man asked in English after I had exhausted my repertoire of greetings in the island language of Mabuiag. Taken aback by his phrasing (I later learned that it meant "why do you come?"), I pushed on to explain that I wanted to learn about local tides and that everyone had suggested that I talk to him, to Gelam. I asked if he could help me.

He sat passively for a long time, looking down at the open tin of tobacco in his hand. I didn't know if he was contemplating what I had said or what to do about his meager tobacco supply. Waiting for his reply, I looked around, absorbing fragmentary glimpses and sounds: good shade where we sat under the native almond tree; scarlet hibiscus against sun glare off clean-swept sand yard; tall, graceful coconut palms and a neat stack of husks drying beneath; a pile of blackened rocks next to a pit in the sand where a green turtle had been cooked, Islander-style, in an earth oven on a bed of hot rocks, covered by leaves, coconut mats, and a mound of sand—and from a nearby corrugated tin sided house, the strains of a guitar, as the player tried to follow "Country Road" from a John Denver tape, and the sputtering hiss of a "Handi" kerosene burner in the kitchen.

"How much you know about tides?" Gelam asked, suddenly and directly.

Startled from my languid inventory, I replied, "A little, but I have these books," and pulled out Volume III of the *Australian Pilot* and the latest *Official Tide Tables for Queensland.*

"What they say about Torres Strait?"

I read a few excerpts aloud.

"You know nothing about tides, then. *Aiginga.* Nothing." He frowned and shook his head sadly. Long pause. "Okay, *baba,* I teach you about tides and everything."

Learning about the tides took an inordinate amount of time and it was the "everything" that caused it. I had always believed that natural history was in many ways the study of cultural history, but I never imagined it was also an "everything history."

Each morning, day after day, I met with Gelam under the shade of the *meke* tree. He talked in part of tides and winds and currents; about *kulis,* which runs with the wind in the southeast season, and *gutat,* the good dugong and turtle tide, which runs against the wind, and of how they change during *kuki,* the northwest monsoon season—*kulis* then flowing to the east and *gutat* to the west. About tides that run "straight" during first- and last-quarter moons, with regular and uniform movements, but then change to the confusing patterns I had observed: missed cycles, simultaneous high and low tides on opposite sides of a small island, and sluggish low tides that seemed asleep on the coral sand flats. He told me when to look for clear- and dirty-water periods; times of the day, month, and seasons when dugong were bunched on the reefs or scattered or in deeper waters; how currents, winds, and island and reef configurations influence tides and the occurrence and distribution of marine life; when to expect a "big low tide" so that Judi and I could go out to find dugong feeding trails on the drying shallows; how dugong "change over" from deepwater to shallow-water places as the tides and moon change; and how the turtles follow the tides.

"When dirty water big tide and want to spear dugong, like only fat one, we go to Red Fruit Island side. If go to Kuiku Pad Reef, only find bad dugong, not much fat. If want to look turtle and full moon, go to reefs when low tide, find them proper on top, shallow place."

Armed with this sort of information and with a new and strange set of environmental cues to aid us, we confirmed many of his observations during our afternoon and evening trips to the reefs.

Data on the marine environment and the area's natural history had to be pieced together from a thick pile of notes filled largely with tangential material. Despite my efforts to keep him to subjects that I wanted to hear about, he was not to be rushed or directed or prompted. I soon abandoned attempts to channel the cascade of personal experiences, myths and legends, local and tribal history, old hunting lore, and principles and perceptions of marine ecology that rushed from the floodgates of his mind. Never knowing when a stray piece of information relevant to our research might appear, I wrote and taped everything. He was the eldest
of his clan, the historical custodia
knowledge seldom required in "tl
modern times."

He told of the time "before
light came"—prior to 1871 wher
London Missionary Society cam
based on what his grandfather
told him, and of "before tim
when he was a boy, and "after be
time," when he was a young man
worked on pearl shell lugger
"when crew hard work and l
money"—of collecting trochus sh
"outside, breaker side of barrie
and of the coral cuts, sharks, and r
stench of trochus meat rotting in
holds; of his days in the all-Islar
Torres Strait Light Infantry Batta
during World War II, when "all
boys join, fight for Australia."
about American troops on Horn
land and the baseball games and
waiting in the sun for somethin
happen and of the cigarettes—"
time we get tobacco proper go
Yankee cigarette, taste nice." And
told of the years following the w
end when things began to cha
quickly and the young people be
leaving the homeland islands
Thursday Island, Bamaga, Cair
Townsville, Brisbane, and Kuri B
"Very seldom they come back. T
forget these places. They lose the
land ways."

He drew pictures in the sand
constellations that signaled the
pearance of seasons and the mo
ments of sea life, outlines and m
of reefs and channels, and sketche
different animals. He could imi
the swimming and feeding beha
of most sea creatures with convinc
gestures. He was a wonderful
server of nature.

Gelam then began to tell me ab
calling the wind and calling dugon
He had the "medicine" and knew
"deep language" that enabled hin
do these things. "Only I know th
things, from olden time peo
These younger generation kn
nothing but to hunt and eat. Th
why plenty dugong here now—I
them. I call them to come to this
land."

And he showed me the medic
and what you do with it and what
say. Roughly translated into Engli
the call goes like this: "Don't stay
sea outside, too rough. If you s
outside you will *sarup.* Come cl
to island. Then if you want to brea
you can with tail on reef. You're
safe place now."

There was more to tell and sho

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You'll see the few simple facts (that when) put together are called music. You'll see the almost magical formula which makes the basic chord. You'll see the skeleton that holds all music together . . . a simple, basic structure you will build on your own piano in a matter of days.

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2. In order to make music, you have to know your scales and do your exercises fluently. It takes a year at the least—and closer to two—before your study pays off and you are prepared to play the piano. There are no shortcuts. **WRONG.**

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and I began to wonder when and where it would all end. We were going far beyond my original request to learn about local tides. The juxtaposition of practical and mystical knowledge made me uneasy and my mood and responses became increasingly more skeptical. Sensing this, Gelam said one morning, ''The old people teach me what they knew and how to take notice of things. Everything come from taking notice of things. I tell you what I know and then you can write it in your book. Then these new generation will read that and they'll know how it was.''

I had become entangled in Gelam's desire to preserve the old traditions and the old knowledge. But my background, with its own beliefs, myths, and legends, and my training conflicted with his. He lived in a world different from the external one we shared as visitors to the island and so his perceptions were different. We reversed roles and he listened to my explanations of scientific methodology; of what caused tides and winds and the movements of some animals in the sea.

After I had finished, Gelam tilted his head and smiled. His smile meant: ''You poor modern times man. You'll never know about taking proper notice of things.''

And Gelam was undoubtedly correct. I would never believe in all those wondrous things that linked stars, winds, tides, animals, and Islanders together in one mysterious cosmos.

One day, two villagers, Tamu and Kadi, announced that they had to ''go T.I.'' (Thursday Island) on personal business—it being the only commercial and administrative town in Australia's northernmost region—and asked if I wanted to come. I had a shipment of film to mail off, and this seemed like a good opportunity. Barney, my son, also came along, to buy more fishing tackle and to touch base culturally in a place where there were comic books and soft drinks. It was to be a routine, two-day, there-and-back trip in Tamu's 14-foot aluminum dinghy, and Gelam came down to the beach to see us off.

As Gelam helped push the dinghy down the beach into the water, he whispered to me, ''You look for those *passis* and *gat* I tell you about,'' referring to the channels and reefs he had drawn in the sand. He said something else, but it was drowned out as Tamu started the motor.

Three hours later, heading south, cutting across the reefs and deep-water channels, we lost power. We drifted while Tamu and I took enough of the motor apart to confirm that it was a broken drive shaft. Perfect timing too. We were halfway through the widest stretch of open water; Thursday Island was a long way off. Our situation was difficult: no hopes of fixing the motor, no boats on the horizon, no wind; our stores, two gallons of water and a bag of overripe mangoes warming in the open dinghy. We talked about our predicament for a few minutes while the *kulis* tidal stream rapidly carried the dinghy toward the open sea, the Arafura.

We were in mid-channel, between reef sets, too deep and too much current to drop the anchor. We took shifts on the lead-heavy oars and rowed for the next reef, but we lost headway as we tried to cut across the channel. These channels frequently have tidal streams that run at five and six knots. At last, exhausted and anchored over the reef, and hoping for an early rescue, I asked Tamu and Kadi if many boats followed the route we had taken.

''No worry, plenty dinghies on the weekend,'' Kadi assured me.

I reminded him that this was Monday.

We couldn't row against the flood tide and with no wind to try an improvised sail, we waited for *gutat*, the ebb tide. Barney began reading Michener's *Centennial*—I hoped we would get to Thursday Island before he finished it. Kadi, always hungry, went to the bow to watch for mating green turtles, which drifted on the surface at this time of year. I didn't ask how he planned to cook the meat if he caught a turtle. Wearing a pink lavalava, day-glo green rimmed sunglasses, and a knotted handkerchief for a hat, Tamu sat in the stern, just looking at his motor and saying, ''My or my, why you do this to me?'' And I made a little tent to protect the box of exposed film from the sun and wondered if I should start a log.

In the October calm we waited for the change of tides. The searing sun heated the boat to what felt like solar-cooker levels. Late afternoon haze, sea, and sky blended into a uniform, silvery gray Möbius band. Sea glassy over the reef, swirling in the channel. Deadwind time before the northwest monsoons.

We started to row at sundown but the slack tide was short and we didn't cover much distance until the ebb tide started. It was hard to see how were doing in the rapidly fading li When it was really dark, Tamu vised that we should anchor for night on the next reef. He feared we would drift too far the other with *gutat*. Anchored again, talked of turtles. Tamu taught m count to twenty in Mabiuag and picked mango strings from our te The heavy, somnolent night lay h on the sea. No breeze. We would the tides again tomorrow.

Eleven in the morning: Hamm Island close, Thursday Island just hind, Prince of Wales Channel stil cross, the worst one. We were tir hungry, sore.

Kadi noticed it first. ''Wind c ing. *Sager*.'' East wind.

We quickly made a sail out Tamu's lavalava, used the oars masts, and sat back. With this un pected wind we would make Thu day Island easily. Near the isla three turtle hunters attracted by pink sail—you hardly see sails in t part of the world, much less p ones—changed the course of th dinghy and towed us in.

''We almost *sarup* out there, she's right now,'' Kadi said afte long pull on the water bottle. ''Y can book this trip.''

The morning after we retur home, I found Gelam on the be and told him about our trip. He tened and nodded his head kno ingly. Then he told me what he h done.

''When you didn't send radio m sage to Judi, she come and tell m Lucky for you she did, too. I kn then that something happen becau you didn't reach T.I. She ple worried. But I fix everything. I c that wind up. That night you out the reef, I go to beach and ma mark, call wind for next day. Gi you push to T.I. You believe now?''

''Let's say I believe more than I c before, *ate*.'' I thanked him, but waited for me to say something el

''Now about this word *sarup*, wh exactly does it mean?''

''*Sarup*? Well, *sarup* means person lost at sea.' In before the lig times, you *sarup* if your canoe ca size or you lose your way. Y stranger to the homeland then. If y come back, they might kill you, off your head. But these mode times different, now we say. . . .''

And we walked back together to beneath the *meke* tree.

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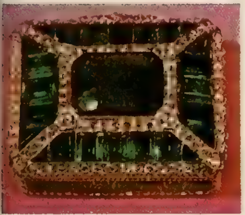

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A Whooper Rally

by Rodney Barker

It's the bottom of the ninth inning for the whooping cranes . . . the cranes are in scoring position

Since 1850, North American wil
life has changed drastically in comp
sition and abundance, largely b
cause of a rapid transition from pri
tine to civilized conditions. A prin
example is the whooping crane. Th
bird, which had ranged across th
marshes and prairielands of Americ
retreated before white man's wes
ward settlement until its breedi
grounds in the United States had a
been abandoned. Its period of declin
continued through the 1930s, un
only one migratory whooper flock r
mained in the wild, wintering in
single marsh on the south coast
Texas. In 1937 the United States go
ernment, in an effort to protect th
species from extinction, purchase
this area as a migratory waterfowl re
uge, since named the Aransas N
tional Wildlife Refuge.

Further conservation efforts we
stalled by a lack of knowledge. Th
notebook on the whooping crane wa
slim. Even the whereabouts of th
whoopers' nesting grounds were n
known until 1954, when they we
discovered and it was learned that th
birds journeyed into the Northwe
Territories of Canada near the Alber
border in order to rear their youn

*An accepted member of a sandhi
crane flock, a yearling whoope
forages for grain in a harveste
cornfield near the Bosque d
Apache refuge in New Mexic*

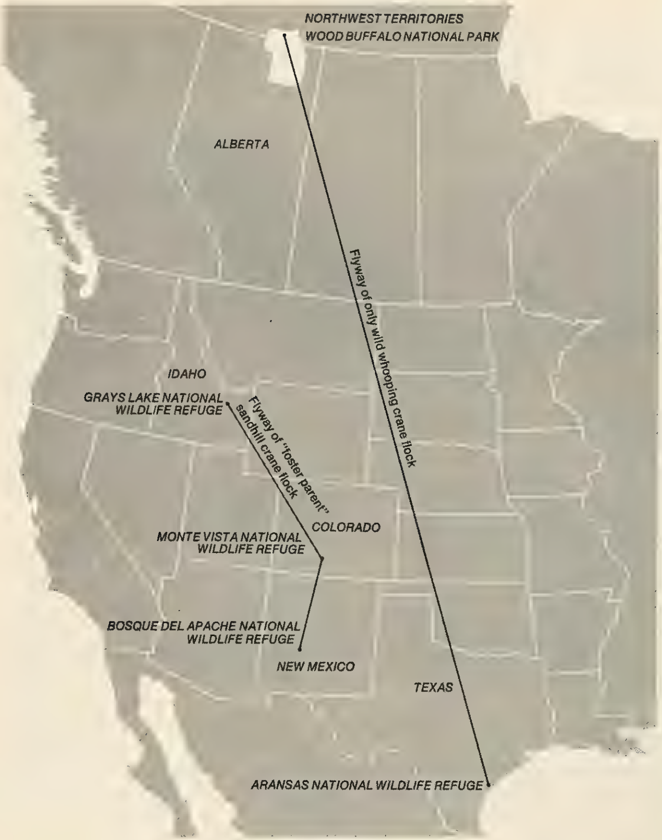
hout interference or disturbance.
he discovery of the breeding
nds in remote marshes of Wood
falo National Park did little to as-
the salvation of the species. Only
nty-one whooping cranes were
in the wild by then, and while the
ated nesting grounds provided
ection, the far northern location
nt a short nesting season. If a
ch of eggs was destroyed by a
m or a predator, there would not
much time for a second nesting.
thermore, the cranes' migration
te was long and dangerous: 2,600
es from Wood Buffalo to
nsas—and the whoopers made the
ht twice a year.

movement to increase the popu-
on of whooping cranes followed, and two schools of thought developed about how this could be best accomplished. One accepted that the species had been condemned to extinction in its natural environment and that captive propagation was the only hope. The other felt the birds should be left to themselves and that over time, and with stringent protection, their status in the wild would be enhanced.

There were problems associated with both viewpoints. On the one hand, captivity-induced changes could result in the loss of traits essential to the bird's survival in the wild, and no method had yet been devised to condition captive birds in a way that would eventually allow their release. On the other hand, a wild population can be given only so much protection. For a species whose numbers had been diminished to less than two dozen, and which has a very low reproductive rate, the prospects for a natural resurgence seemed slim.

The priority at the time was to increase the whooping crane population by any and all means, and to accomplish this the U.S. Fish and Wildlife Service and the Canadian Wildlife Service began a program in 1967 that involved transporting eggs from whooping crane nests in Canada to the Patuxent Wildlife Research Center in Laurel, Maryland, for artificial incubation, hatching, and raising. The objective was to establish a captive breeding flock that would eventually produce enough birds to restock the wild population.

Rod Drewien


NORTHWEST TERRITORIES
WOOD BUFFALO NATIONAL PARK
ALBERTA
Flyway of only wild whooping crane flock
IDAHO
GRAYS LAKE NATIONAL WILDLIFE REFUGE
Flyway of "foster parent" sandhill crane flock
COLORADO
MONTE VISTA NATIONAL WILDLIFE REFUGE
BOSQUE DEL APACHE NATIONAL WILDLIFE REFUGE
NEW MEXICO
TEXAS
ARANSAS NATIONAL WILDLIFE REFUGE

The feeling was that the removal of one egg from a whooper nest would not hurt the wild flock, for of the two eggs normally hatched in each nest, sibling rivalry and competition for food usually meant only one chick survived. Eggs were taken from whooper nests beginning in 1967, and by 1974 a potential captive breeding flock of nineteen birds had been reared from fifty eggs at Patuxent.

Whooper numbers, in the wild and in captivity, were on a slow upswing, but two major factors continued to hinder the increase of the species. First, an insufficient number of birds produced in the wild were going back into the breeding flock. No one knew what was happening to them, but too many of the subadult group were vanishing before they had a chance to contribute to the breeding population. Second, the belief that animals reared successfully in captivity should exceed, by several times, the customary productivity of the species in the wild was not holding true in the case of the whooping crane.

At this crucial point in whooping crane history, Rod Drewien and Elwood Bizeau, research biologists at the University of Idaho, came forward with a proposal to start a *new* wild population of whooping cranes. Drewien and Bizeau had been working for six years with greater sandhill cranes, close cousins of the whooper, and had completed a comprehensive study that involved catching and banding some 700 sandhill cranes, following them up and down the Rocky Mountains on their migration route, and experimenting with egg switching. Their research indicated that cranes are imprinted; that is, their social behavior is learned through early experiences. Drewien and Bizeau then extended the implications of their studies to whoopers. They proposed that the eggs being removed from the wild for incubation at Patuxent be deposited instead in the nests of preselected sandhill cranes at
Grays Lake National Wildlife Refu
in Idaho, and that the sandhills be p
mitted to raise the whoopers as th
own. They believed that sandh
cranes would make good fos
parents: both species maintain li
long pair bonds and family grou
both lay two eggs that are similar
size and appearance and that hatch
thirty days. The biologists were co
vinced that the adopted whoop
would learn from the sandhills to a
just to a new environment.

Drewien took the view that "
face of the continent is so chang
that the whoopers may not be able
reoccupy much of their histori
range, which has been drastically
tered or eliminated by man. The ori
inal habitats are not there anymo
We believe that the whooper is a lit
more adaptable than we give it cre
for. With this restoration project
are simply trying to take advantage
similarities between two speci
switching eggs and then letting natu
take its course."

The objectives of the proposed e
periment were multiple. Obviousl
it was important to increase t
whooping crane population in a
way possible. But to Drewien, she
numbers were not the most importa
statistic: "Anything more than w
have is a better number, but the tot
number is not as important as esta
lishing separate flocks. A hurricane
an oil spill at the wintering groun
could wipe out the entire floc
whether there are 50 birds in it or 25
It would be far safer having those 2
birds in separate flocks. Security f
the whoopers is in dispersal of t
species."

Past events dramatically unde
lined this statement. In 1940, tw
populations of whooping cranes ex
isted in North America: a nonmigra
tory flock, living in the coasta
marshes of Louisiana, and the full
migratory birds that wintered a
Aransas. That year a hurricane hit th
coast of Louisiana, and all but six o
the nonmigratory colony of whooper
disappeared. All of the Louisian
whoopers were gone by 1949.

In addition to bolstering the popu
lation, the establishment of a secon
and separate whooping crane floc
meant the whoopers would have a dif
ferent set of winter and summe
ranges. No migratory species can b
kept on a managed habitat or unde
protective observation all the time
but the banded stock of sandhills fron

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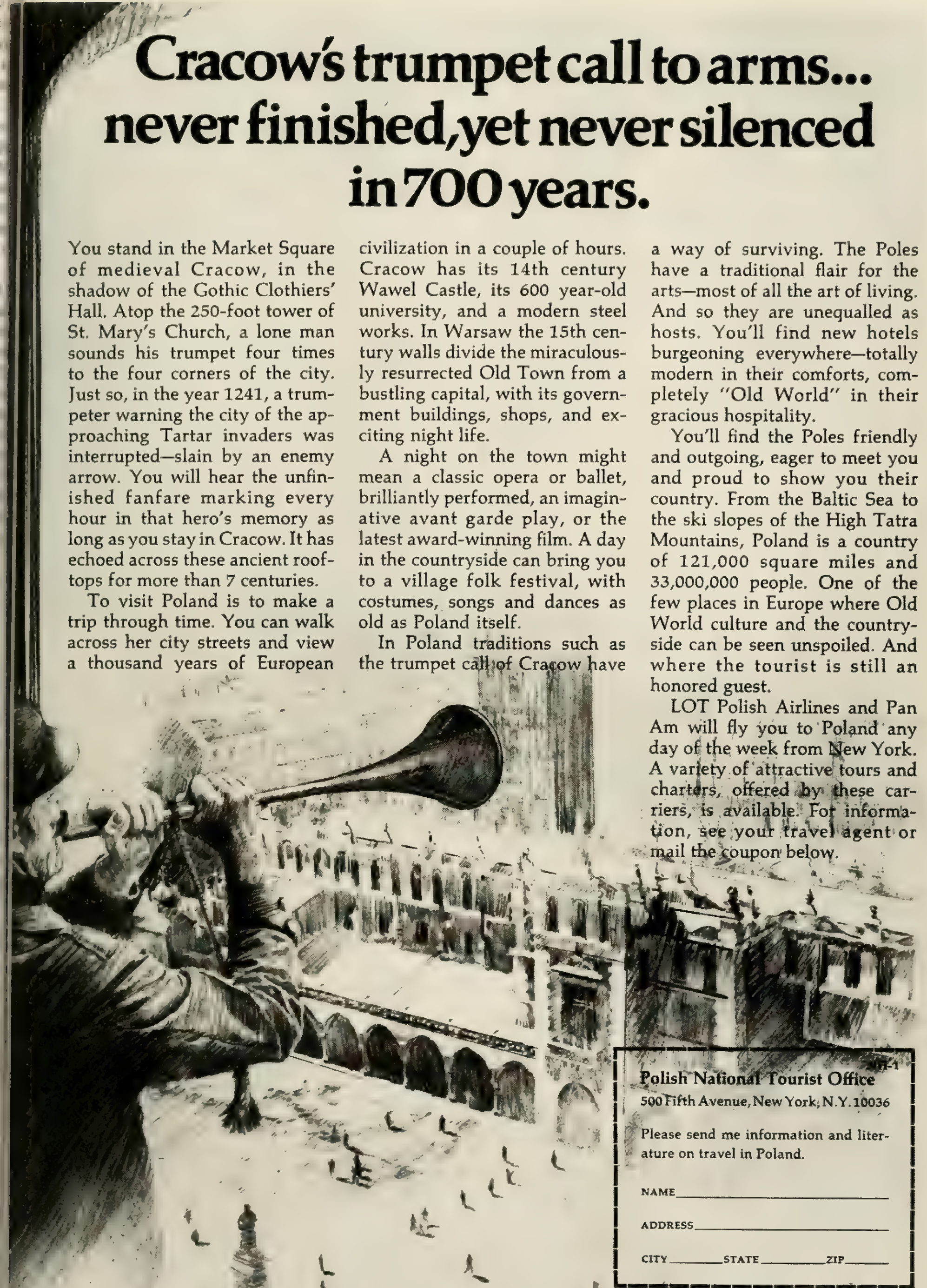

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POLAND, a land of never-ending fascination

which Drewien intended to draw his foster parents wintered and summered on national wildlife refuges—Grays Lake National Wildlife Refuge in Idaho and the Bosque del Apache National Wildlife Refuge in New Mexico—and on each flight, north and south, stopped over to rest and feed at, or in the vicinity of, the Monte Vista National Wildlife Refuge in Colorado. The 800-mile migratory journey from Idaho to New Mexico was less than one-third the 2,600-mile Canada–Texas trek.

Many questions stood without answers. Would the sandhill cranes accept the whooping crane chicks once they were hatched? Would the whoopers continue the same migration route of their foster parents when they had to fend for themselves? Although plumage, size, mating calls, and ritual courtship dances of the two species differ considerably, would the sandhills and whooping cranes attempt to interbreed in a wasted reproductive effort?

Calling it a grand experiment to provide a lot of answers, the U.S. Fish and Wildlife Service and the Canadian Wildlife Service approved Drewien and Bizeau's proposal and the project was begun in May 1975. The Canadian Wildlife Service made plans for the eggs to be picked up by helicopter on May 28. There are variations in sensitivity to nest visitation among species, and no bird will stand for sustained disturbance. A direct approach, quick actions, and a short time spent at the nests of whooping cranes had been found to be acceptable during earlier operations of the Patuxent project, and it did not appear to bother the parents when one egg was removed.

The eggs were left under their natural parents until approximately one week before they were expected to hatch; at that time Ernie Kuyt, a biologist with the Canadian Wildlife Service, flew to the vicinity of each nest. He removed one of the two eggs in each nest (where three eggs were found, two were taken). The eggs were immediately placed in a portable incubator, and when the collection was complete, fourteen eggs had been taken, with seventeen left for the Canadian flock.

On May 29 the eggs were flown to Grays Lake and substituted into the nests of sandhills. Drewien drew from a stock of one hundred banded sandhill cranes, and his primary criterion for the selection of the foster parents was the predictability of their migration from Grays Lake to Bosque del Apache.

Of the fourteen eggs taken to Idaho in 1975, three were found to be infertile. This was Drewien's first surprise. ‘‘That threw me, three eggs being infertile. I didn't expect that—based on similar samples from sandhills. I had never run into that percentage of infertile eggs before.’’ Two eggs became meals for coyotes. Of the nine eggs that hatched, six chicks reached flight stage and three were lost to unknown causes.

From the time they hatched to the time they migrated, the young whoopers were twice approached by humans: once when the nests were checked to make sure the eggs had hatched and again when the remaining young were banded at two months of age.

One more bird was lost prior to migration on October 8, when the first whooping crane wheeled upward in circular flight with its sandhill parents and headed for the Monte Vista National Wildlife Refuge, 500 miles away. By October 20, four whoopers had arrived in the San Luis Valley of Colorado at or near Monte Vista National Wildlife Refuge to rest and feed. The four foster parent families continued on to New Mexico; two settled in the Bosque del Apache refuge, a third family stopped at the Bernardo State Game and Fish Department Refuge, and the fourth came to rest on a dairy farm near the town of Los Lunas. Reports of a large white bird wintering with a sandhill crane flock in northern Mexico left hope that all five had safely completed their annual southern migration. With one bird not officially accounted for, adding these four whoopers to the eight chicks raised by the 49-bird wild flock in Canada represented the largest annual increase in the wild whooping crane population ever recorded. That made a total of 85 wild and captive whooping cranes in existence in 1975.

Drewien followed the birds to Bosque del Apache refuge, monitoring their activities and behavior and watching the interactions between the young whoopers and their foster parents and other sandhills. It appeared that the whoopers were acting like normal sandhill young and being treated as such by their foster parents, but not by other sandhills. There was a tendency for the whooper families to feed on the edge of the flock because the young whoopers were quently harassed by other adult sa hills. Most importantly, howe they were adopting the sandhills' and their roosting and feeding cycl

Drewien and wildlife officials w optimistic about the whoopers' al ity to pass their upcoming te Would they follow their fos parents back along the migrat route to Grays Lake? And what w going to happen upon their arriva the breeding grounds? Sandh breeding pairs, which are stron territorial, drive yearlings off prior a new nesting season. Left with the protection of the mature birds a forced to shift for themselves on un miliar feeding grounds, the you whoopers would enter a time wh they were highly vulnerable to los

A short mild winter brought sandhills north one week earlier th usual, and by March 2, 1976, the fo whoopers had arrived in the vicin of the Monte Vista refuge, with fifth bird still missing.

While in Monte Vista, the you whoopers were constantly under vigil of refuge manager Pete Brya who observed that although t whoopers congregated with oth young sandhills, ‘‘one of t whoopers was a leader. Juven sandhills were attaching themselv to that whooper rather than the oth way around.’’ Bryant's observati that the whooping cranes appeared be dominant in the juvenile grou suggested to him that a pattern of s gregation was already developi that would eventually lead to natur separation when the birds reach sexual maturity and selected mates

Then an unexpected developme occurred: the sandhill parents conti ued their migration north, but on one whooping crane went with ther The other three stayed behind Monte Vista.

Pete Bryant felt the birds remain ‘‘because there was nothing to mo them. Conditions were good and ge ting better. There was plenty of wat and food around.’’

Two of the young whoopers left April but two stayed until May 1 When they left they scattered to th north; only one made the full migr tion that the adult birds did to th grounds where they were hatched ar raised. (This individual summere within twenty miles of Grays Lake

Drewien was not worried abo this development because some san hills follow the same pattern. B

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there was no way to measure the i plications because there was " norm to compare them to. To t day, nobody knows where the you whoopers [in the Canada flock] g We know most don't go back where they were reared, and it m just be characteristic for them disperse as subadults. The one thi that is traditional is that most do show up in the nesting areas."

Of the fifty-seven birds that w tered at Aransas during 1975–7 only thirty-six showed up at the ne ing grounds in Canada that sa spring. Twenty-one summered els where, and no one knows where th went. The assumption is that these a subadult birds, and that they summ in areas other than the nesti grounds, spreading out over a lar area and only rejoining the rest of t breeding flock after they have reach sexual maturity and are paired u Last year a new pair that had not be there previously showed up at Wo Buffalo National Park.

On the whoopers' northward m gration, one landed in south-centr Montana, there was one in northea Utah, and another was also report in that state. The fourth, as me tioned, ended up near Grays Lak Two were observed in the compa of juvenile sandhills, and one was b itself. From all observations, the su adult whoopers were on a grain die although they were spending mo and more time foraging in marsh and wet meadows for frogs and oth small aquatic life. They were also o served feeding on such insects grasshoppers and dragonflies and c young birds and bird eggs.

The experiment was begun wit the idea that if it was succeeding aft one year, it would be continued. Th addition of four whooping cranes t the wild stock substantiated the dec sion to repeat the experiment for second year.

Sixteen eggs were picked up i Canada last spring, but one egg, re ceived from a pair that had supplie an infertile egg the previous year, wa infertile and was kept in Canada fo museum purposes. So fifteen egg were brought to Grays Lake an placed under selected sandhills. I addition to this supply, two eggs tha had been produced in captivity at Pa tuxent were brought to Idaho in th first attempt to utilize the captiv breeding flock to bolster whoopin crane numbers in the wild. Some egg were placed under the previous year'

nts and some under new parents.
uickly, the bad luck that has hin-
d all efforts to assist the whoop-
crane struck again. Coyotes got
nd cleaned out a line of twenty-six
dhill nests, including four with
s brought from Canada. Eleven
ls hatched, but one died of pneu-
nia within two days. Within a
k after the last had hatched, Grays
e was hit by a four and a half day
m that brought rain, snow, and
zing temperatures. Three more
ks disappeared, reducing the
ber of surviving young whoopers
n ten to seven. Three more were
to unknown causes over the sum-
. Drought conditions and the re-
ant lack of food were blamed for
se last fatalities, as a number of
ng sandhills were observed in
ving condition. It was a poor year
cranes at Grays Lake.

he fate of the two eggs brought
from Patuxent was consistent.
wien had been warned that there
not appear to be a developing em-
o in one of the eggs; nevertheless,
h were placed under sandhills.
one considered good did not
ch on its due date, but it was left
on the chance it might still come
ugh. Four days later it was eaten
ravens. The one deemed infertile
s also eaten—the day after it
uld have hatched.

our young whoopers reached
ht stage and flew south in 1976. At
nte Vista, one of those extended
string of bad luck when it flew into
usty barbed-wire fence and died
m injuries sustained in the colli-
n. The three survivors continued
to Bosque del Apache. As it turned
, the sandhill parents that success-
ly reared the 1976 crop of
oopers were not the same ones that
had success the previous year.

Meanwhile, the four yearling
oopers who had scattered to the
rth for the summer came back to
ir previous wintering grounds on
ir own. One was reported about
ty miles north of the Bosque del
ache refuge in early October, but
n it apparently moved farther
uth. It hasn't been seen since, and
ewien thinks it may have joined a
up of young sandhills heading
uth, which continued across the
rder into Mexico. Two remained at
sque del Apache and the other
nt the winter at the New Mexico
me and Fish Department refuge at
arby Bernardo—proof that whoop-
cranes placed in a new geo-

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graphical area will remain in that area after they have left their parents.

Assuming developments continue as they have, the project seems on its way to ultimate success. In 1976, fifteen new whoopers were added to the wild whooper count, as the Canadian flock contributed twelve young. The previous high was also twelve, and that was in 1975. Before this project was begun the best score on record had been a ten, in 1964. (The total number of whooping cranes, in the wild and in captivity, is now about one hundred.)

After two years, the restoration project is still in its infancy, but numerical results and informative answers have justified the initial risks. "Beyond any doubt in my mind now," Drewien said, "I'm confident this method will work, as far as rearing the bird, fledging it, and taking it south." He has expressed little concern over the birds scattering to different summer grounds because while the distribution was spread over several states, it was all within the same geographical range occupied by the sandhill crane population into which they were introduced, and each area contained the same basic habitats—grain fields and wetlands—utilized by cranes at Grays Lake. "The more we see, the only real question left is will the whoopers get together and pair or will they attempt to pair with sandhills. The key to minimizing this potential problem is getting enough whoopers introduced into this flock so that when they reach the age when they start to pair, they can have an opportunity to come in contact with each other, among the thousands of sandhills."

Drewien feels the answer could very well lie in the captive breeding flock at Patuxent, for assuming everything continues as it has, then the only limitation is the number of eggs that can be gotten.

"One of the values of the captive flock, besides, of course, maintaining and perpetuating a gene pool aside from what is in the wild, is that it can contribute significantly to the restoration project. It is going to be a long program, and if Patuxent can break down the barrier of getting eggs out of the adults and get them producing—and they have approached it already with three eggs in 1975 and five eggs in 1976—then we could supplement the wild eggs with those eggs produced in captivity, and we could rapidly increase the number of whoopers. I think that to be able to depend only on eggs that come out of Canada may not be enough."

He feels a couple of dozen whoopers must be available in the new population to give them a fair chance to breed, and that once there is the capability of putting out two to four dozen eggs a year, "knowing what success we've had in bad years—25 percent coming through—we could break the barn door down on these whoopers."

The biggest problem the project has encountered thus far has been the high loss of young during the nesting and rearing period. Some of this was due to adverse environmental conditions. The past two years have been subaverage years weatherwise, as drought conditions, together with storms at the wrong time, have taken their toll. But in two years, six eggs have been lost to predators, and that is one factor that something can be done about. A coyote-control program will be administered at Grays Lake this spring (the loss of eggs to coyotes last year was due to a single pair that moved into the marsh nesting area for the first time). But if a predator-control program is not immediately effective, Drewien will consider new criteria in the selection of sandhill foster parents. Ideally he wants a pair that consistently summer on the refuge at Grays Lake and winter at Bosque del Apache, but "I might have to back up and use pairs I don't have as much information about because they have safer nest locations and are less likely to be predated by coyotes."

Besides coyotes, hunters continue to pose a threat to the whooping crane. Historically, the whoopers have been most vulnerable to being shot on their migration south because they cross middle America during hunting season. At the time of this writing, however, the young whooping cranes in the experimental project are being exposed to this particular danger because of counterproductive management practices on the Bosque del Apache refuge itself.

Restricted snow goose hunting has been allowed on the Bosque del Apache refuge for years, but in 1976 the Fish and Wildlife Service, against the recommendations of refuge personnel, proposed to considerably expand the hunt to offer greater opportunities. The bag limit on snow geese and the number of shells hunters could use were increased. A new afternoon hunt was added but th
eliminated ten days prior to the ope
ing of the hunt due to political pr
sure.

"I'm not opposed to hunting
Drewien explained, "but it should
placed in a proper context. Virtua
every year since the hunt has be
held at the Bosque del Apache refug
one or more sandhill cranes have be
misidentified and shot. Last year fi
sandhills were killed. If a person c
mistake a sandhill crane for a sno
goose, he can certainly mistake
whooper, whose color patterns r
semble the snow goose much mo
closely."

Many people feel that the foremo
objective of a national wildlife refu
should be the enhancement of t
wildlife that utilize the area, over a
other use. And when there are co
flicting programs, wildlife should
the top priority item.

In 1975, 659 hunters came
Bosque del Apache after snow gees
the total number of visitors that ye
came to 68,000, many of whom cam
to see the whoopers. In 1976, to a
commodate less than 1 percent of th
public users, the hunt proceeded
scheduled, with refuge agents scurr
ing around trying to keep track of th
whoopers in the morning fog, settin
off sirens whenever the birds fle
near the blinds, stopping the hu
until the whoopers moved on, the
starting it again with an all-cle
siren. The hunt lasted eighteen day
and, fortunately, ended without
whooping crane casualty. But by th
time it was over, the cranes in the n
hunting areas were out of food an
most whoopers were flying off the re
uge to private lands to forage durin
a period when the goose hunting se
son was opening outside the refuge

There are lessons to be learne
from this experimental project th
have valuable implications for man
other endangered species. Already
George Archibald of the Internation
Crane Foundation is in the process o
instituting an analogous program i
Asia with the Siberian white crane
using the European common crane a
the foster parent. If Drewien's projec
works, and the ultimate measure o
success will be the pairing and raisin
of young whoopers in the new flock
then not only will the lifeline of th
whooping crane have been extended
but one of the most triumphant tech
niques ever developed in the restora
tion of endangered wildlife will hav
been established. □

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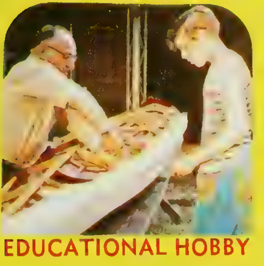

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oison in a Monkey's Garden of Eden

Kenneth E. Glander

*r howlers in a Costa Rican
est, feeding is not just a
tter of plucking any leaf*

ll of the howling monkeys, ex-
t for one adult female with an in-
t clutching her stomach, had fin-
ed feeding and had left the carne
da (*Andira inermis*) tree. Sud-
ly this female started turning in
it circles on a branch, but she com-
ted only two revolutions before
ing her balance. For about a min-
, her tail hold on the limb pre-
ited her from falling and she hung
side down. Then, convulsing spas-
dically, she lost muscle control
l plummeted thirty-five feet to the
und. All the while, her ten-day-
l infant had kept its grasp. Al-
ugh the infant was not injured, the
ther appeared dazed. After recov-
ng, she climbed back into the tree,
t remained sitting in the same spot
the rest of the day and did not feed
the next twenty-four hours.

Her fall was one more piece of evi-
nce that toxic substances in some
the leaves consumed by these man-
d howling monkeys (*Alouatta pal-
ta*) not only determine a group's
ding patterns and movements, but
y also influence its social organi-
tion.

This group of howlers, made up of
o adult males, six adult females,
d five juveniles, inhabited two
pes of forest on twenty-five acres of
ranch near Cañas in northwestern Costa Rica. One is a broad-leaf evergreen forest, which runs along the banks of the Río Corobici. Here, the steady supply of water permits such trees as espavé (*Anacardium excelsum*) and sotocaballo (*Pithecellobium longifolium*) to thrive. Most of these trees are about fifty-five feet high but several magnificent specimens reach one hundred feet.

At a distance of seventy-five feet from the river banks, the ground is much drier and the gallery forest gives way to a deciduous one. During the dry season from December through April, the difference between the two forests is most dramatic: the dense green canopy of the gallery forest contrasting sharply with the bare limbs of the deciduous one. During the wet season from May to November, however, the canopies of the deciduous forest are as thick as those of the gallery forest.

In many places the canopies touch, allowing the howlers to move directly from one tree to another. But where cut or blown down trees have created gaps in their travel routes, the howlers usually hesitate momentarily before flinging themselves out into space to land safely in the crown of a neighboring tree. All of the animals, except for those younger than four months old, routinely make these jumps. When these young animals come to gaps that their mothers have already crossed, they edge out to the very ends of the branches and squeal until the mothers cross back to get them. As a result, many of the females have to jump the same gap three times. But by the time the juveniles are six months old their mothers no longer pay attention to their squeals and they must jump the gaps themselves or be left behind. During our fourteen-month study of the ecology of mantled howling monkeys, we observed over seven hundred jumps and never saw an animal miss.

My wife and I had completed only three months of our field work when we saw the mother and infant fall from the carne asada tree. There had been other, similar occurrences within a short time span. During the late afternoon of the previous day, the group had traveled from one side of the Río Corobici to the other, using a natural pathway along the limbs of trees that almost touched. They crossed safely on this occasion, just as they had many other times. We did not wade the river to follow them since darkness was already approaching, but we could see them feeding in the same tree from which the female and infant were to fall. Almost half the tree's crown hung over the river, as did the crowns of some of the sleeping trees used by the group that night. The next morning one of the juveniles was missing. We suspect that the missing juvenile fell and drowned in the river because we could not find his body after a thorough search of the area.

More than a month later, the infant of the female that fell from the carne asada tree drowned in the Río Corobici. On that morning, it was riding on its mother's back while she fed in the crown of a tree that leaned out over the river. We were following another female feeding in a nearby tree when we heard a splash. Upon searching the river, I found the dead infant in three feet of water.

In the two weeks prior to the female's fall, six howling monkeys from other groups on or near the ranch were found dead. I recovered the intact bodies of three animals, all females, for examination, but the other three were too decomposed. During the same two-week period we also found two juvenile females from another group twitching and jerking on the ground. The younger animal, about six months old, died within four hours. The older one, some eighteen months old, recovered.

At least three of the six dead ani-

*cent evidence suggests that
avoid poisoning, howling
nkeys—previously thought to
ve a virtually endless food
pply—must be highly selective
the kinds and amounts of
getation they consume.*

. Glander

mals and both of the sick ones had been feeding on the leaves of either carne asada or madera negra (*Gliricidia sepium*) trees. The mature leaves of madera negra contain rotenone, a fatty acid called archidic, and an unknown alkaloid. Rotenone is one of the ingredients in some insecticides. In Venezuela, Indians crush madera negra leaves and mix them with water and rice or seeds for use as a rat poison. The leaves of carne asada contain the alkaloid andirine. Five grains of andirine will make a human nauseous. Colombian Indians poison fish by putting crushed carne asada leaves in lakes and rivers.

The unexpected and unusual concentration of dead and sick animals, and our knowledge of what some of these animals ate just before they died, provided us with an opportunity few other field researchers have. The combination in tropical forests of rapid decomposition and efficient scavengers, such as insects and vultures, makes the remains of dead animals quickly disappear. When remains are found, it is usually extremely difficult to discover what the animals consumed just before death.

Tests carried out by the Microbiology Department of the University of Costa Rica ruled out the possibility that the monkeys died from herpes virus, rabies, or yellow fever, and extensive autopsies of the animals produced no apparent pathologies. We were left then with strong circumstantial evidence of natural poisoning by ingestion of toxic leaves.

In order to verify or negate this hypothesis, we began to analyze all plant materials in our study site. The present emphasis is on testing for alkaloids. Although the procedure is accurate, it shows only the presence of alkaloids, not the type. The results are promising, but chemical analyses are just beginning.

We have a much more substantial amount of information on the feeding behavior of the howlers. My wife and I have now spent more than 5,000 hours in the field, either observing the animals in their daily activity or studying their habitat. We have systematically documented the distribution of their food resources by marking, measuring, mapping, and identifying the 1,699 trees in the study area. While in the field, we also kept weekly records on the leafing, flowering, and fruiting of the trees.

The annual rainfall in the howlers' habitat area is about 70 inches, but when we did our study in 1972 and 1973 only 56 inches fell during a twelve-month period, most of it from May through September. No rain fell in January, February, or March. In the wet season, the dense leaves provided shade for us and the animals.

During the wet season, the howlers begin feeding at about 6:30 in the morning and intersperse feeding bouts with periods of moving from one feeding area to another. Toward the hotter middle hours of the day, when temperatures reach about 85°F, they usually move to the lower canopy to seek a shady place for resting. Here, an animal stretches out with its legs straddling a branch and its tail wrapped around it. Infants and juveniles often explore the immediate area around their mothers or play in the tops of the trees during these periods. In a resting position a howler is often difficult to spot from the ground because its coat color blends with the shifting patterns of sunlight and shadows filtered through the tree branches. A second peak of feeding usually begins about mid-afternoon and continues until the group settles into sleeping places at about six o'clock in the evening.

The pattern of daily activity is similar during the dry season, except that the first feeding occurs at about five o'clock in the morning; by seven all the animals are resting again. Temperatures during the dry season are hotter, often reaching 100° F. By feeding earlier, the animals can rest in the shade through the hottest part of the day and feed again in the cooler late afternoon.

When we observed the animals during daylight hours in the wet season, they spent an average of 7.9 hours resting, 2.5 hours feeding, and 1.4 hours moving, as compared to an average of 8.6 hours, 3.0 hours, and 1.3 hours, respectively, during the dry season.

The tree parts that the howlers eat, and the time they spend doing so, vary from day to day and from season to season. During an average wet-season day, the animals might spend 38 minutes eating mature leaves; 47 minutes, new leaves; 23 minutes, fruit; 32 minutes, flowers; and
minutes, leaf stems.

During the average dry-season da
they spend 21 minutes eating matu
leaves; 104 minutes, new leaves;
minutes, fruit; 33 minutes, flower
and 18 minutes, leaf stems. The li
ear distance covered in search of th
food may be as much as 1,500 feet

Although the time spent consun
ing each vegetational compone
varies according to season, leaves a
unquestionably of great importan
all the time. Since leaves are alwa
available in a tropical forest, r
searchers have traditionally thoug
that these leaf-eating monkeys ha
an unlimited supply of food.

The results of our study appear
first glance to support this, since th
howlers that we observed obtained a
of their food from only 331, or les
than 20 percent, of the 1,699 trees i
their habitat. Even more surprisin
was that the animals spent 75 percer
of their total feeding time in only 8
trees. This might suggest some dis
cernible pattern in the animals' feed
ing. Do they select certain trees
tree species over others? Is there any
thing unique about the trees they us
or those they do not use?

Indeed, the animals are very selec
tive, showing preference not only f
specific tree species but also for cer
tain trees within a species. Further
more, they do not divide their tim
equally among species or individua
trees. In many instances howlers fee
in only a few trees of a particular spe
cies, totally ignoring other individ
uals of the same species that appea
to have identical food resources.

The howlers demonstrated their se
lectivity in a most dramatic way
There are 149 madera negra trees i
their home range. A common tree i
almost every part of Costa Rica, it i
often used for fence posts. Once
limb is placed in the ground as a pos
it frequently sprouts roots and begin
to grow, resulting in living fence
rows. The tree seldom grows talle
than forty feet and has a spindly
gnarled trunk. The bright pink flow
ers, often fried and eaten in Cost
Rica and Venezuela, grow in dens
masses at the ends of the branches
The fruit resembles an enlarged pe
pod, and the leaves grow in pinnat
clusters of seven to fifteen leaflet
each.

Kenneth E. Glander

Howlers sometimes feed by hanging from their tails and back legs, although this behavior is rare in other New World monkey species. This adult female is eating leaves from a species of Ficus *tree.*

Although mature leaves are toxic to dogs, rats, mice, and horses, howling monkeys eat them, but not indiscriminately. The howlers of the group we studied, for example, ate the mature leaves of only 3 of the 149 madera negra trees available to them, always returning to the same 3 trees. Members of another howler group, which occasionally visited part of the study area, also fed on the mature leaves of the same 3 madera negra trees.

Two of these trees grew next to each other on one side of the Río Corobici, while the third was more than 900 feet away on the opposite side of the river. Although the howlers moved through many of the other 146 madera negra trees scattered throughout their range, they did not feed on the mature leaves of any of these, although they passed through some of them when traveling among the 3 trees. This suggests that there was something different about these trees, something the monkeys could detect. Our laboratory tests revealed that the leaves of these 3 madera negra trees did not contain alkaloids, while the leaves of adjacent individuals of the same species contained fairly large amounts of alkaloids.

If this difference exists for alkaloids, it could also be true for other compounds. The leaves of one of the madera negra trees, for example, did not have cardiac glycosides while its neighbors had large amounts. Like the production of leaves, flowers, fruits, and nectar, the production of secondary compounds is a variable factor. Whatever the results of tests for these other substances show, the presence or absence of alkaloids appears to be critical to whether howlers in this area eat the mature leaves of madera negra trees.

It would seem advantageous then for the howlers to avoid all potentially toxic foods. The problem is that all plants contain substances, known as secondary compounds, that vary in their toxicity. Some tree species in the study area contain more than ninety different secondary compounds. Even such common human foods as celery and spinach contain oxalic acid, 30 and 658 milligrams per 100 grams, respectively. The primary cause of animal deaths from oxalic acid poisoning is kidney failure, resulting from the precipitation of crystals in the kidney tubules. Oxalic acid and many other secondary compounds—tannins, glycosides, organic acids, saponins, essential oils, resins, sulfur oils, toxalbumins—pose a problem for any animal that ingests plant parts containing these compounds.

These secondary compounds protect the plants against insect damage and do not have to kill to be effective. They may serve as repellents by being unpalatable or toxic; they may affect viability of insect offspring or disturb normal reproductive cycles. They also interfere with nutrition by binding certain nutrients, effectively making them unavailable to predators. Tannins, for example, bind proteins. Obviously, not all plants contain the same substances nor is any particular substance effective against all predators.

Among these defensive substances are the irritating oils present in the poison ivy family; hemagglutinins in legumes, which act to disrupt red blood cell functions; peyote alkaloids in the cactus family; cardiac glycosides, which interfere with muscle contraction in the heart; cyanogenic glycosides, which on contact with water yield cyanide; and stimulants, such as caffeine (in coffee and tea) and nicotine (in tobacco).

Any organism that feeds extensively on plant parts must have some means of detoxifying the ubiquitous secondary compounds in order to survive. Detoxification mechanisms vary. One means is through the addition of a molecule of glucose to the toxin, which facilitates its excretion through the urine. This kind of detoxification, as well as other, similar methods, takes place mainly in the liver and kidneys. Another kind of detoxification occurs when bacteria in the intestines break down the chemical structure of the toxins.

As leaf eaters, howlers must acquire food in spite of the toxins present in that food. The role played by the tree's defensive secondary compounds in determining what resources are really available to the howlers must be seen as part of a dynamic relationship between the tree, as prey, and the animal, as predator. A food rich in nutrients is useless unless an animal can handle the toxin that may also be present in it. A dead monkey has little use for nutrients. Howlers certainly have a detoxification system, but they also counter the plant's defenses by preferentially selecting those parts of the tree with the lowest level of toxins. These are the ripe fruits, flowers, and new leaves. When these tree parts are not available or do not provide the proper nutrients for the howlers, they must ingest mature leaves—that part of a tree highest in alkaloids and secondary compounds.

However, the howlers rarely eat the mature leaves of most tree species or, if they do, they consume a limited amount. Instead, they prefer only the petioles (leafstalks). By doing so, they demonstrate their ability to choose plant parts with the least amount of alkaloids.

The selective feeding on particular parts of certain tree species accounts for the animals' dropping large numbers of leaves, a behavior thought by other observers to be wasteful feeding. On the contrary, the animals are selecting that part of the leaf with little or no toxin while disposing of the poisonous part.

The amount of secondary compounds in the leaves and the amount of toxins the detoxification system of the animal can process determine the total number of mature leaves ingested from any one tree species. Depending on these variables, the howlers control the consumption of any one toxin by feeding on a variety of tree species rather than by concentrating on one or two. This strategy may explain why howlers and other leaf-eating animals usually leave a tree before stripping it bare. By eating only small amounts of each kind of leaf, they give their systems time to detoxify the toxin contained in those leaves. Such diversification of food types reduces the amount of any one toxin but requires a broader-based detoxification system to handle the di
ferent secondary compounds. Th
howlers must thus balance t
amount and type of toxins ingest
with the kinds of foods that are avai
able.

Animals are occasionally forced-
by seasonality, overpopulation,
habitat destruction—to feed on unf
miliar trees or to ingest more leav
from a particular tree than they no
mally would. Thus overburdene
their detoxification systems fail a
some animals die. The death of t
seven howlers from other groups, t
female's fall, and the juveniles' co
vulsions were probably due to simil
sets of circumstances.

Group members, particularly old
individuals, may provide a reservo
of knowledge about the habitat. O
an evolutionary scale, knowledge
safe foods and the location and timi
of seasonal foods could select for s
ciable animals living in groups sin
single animals or even a male-femal
pair would not have enough inform
tion to survive as leaf eaters.

Another selection factor for grou
living may be the group's possessio
of a pool of sufficiently diverse fring
detoxification systems such that an
sudden change in toxins or the d
struction of large amounts of pr
ferred food would not be disastrou
for the entire population. The sa
pling of new trees by a single adu
animal may be a behavioral expres
sion of this hedge against catas
trophe. While we observed all of th
adult animals sample unfamiliar tre
species, we never saw more than on
animal at a time attempt this.

The presence of toxins in pla
foods has meaning for human as we
as nonhuman primates. Researche
have cited the use of fire for cookin
as a major evolutionary step for earl
man. The heat of cooking destroy
toxic substances. But how did earl
man cope with toxins before the us

This howler on Barro Colorad
Island in Panama is in a typic
eating posture. Researchers a
not certain whether the larg
size of these animals is due t
the island's dense vegetatio

Geor

of fire? Extrapolations from studies of extant primates indicate that man depended upon a wide variety of plant parts for food. He must have thus possessed a detoxification system, a system that we still retain, as witnessed by our ability to ingest such toxins as caffeine, chocolate, and hallucinogens. Because man now cooks much of his food, however, he may not rely on detoxification to the same extent as did his ancestors. Just as the destruction of toxins through cooking may have liberated our ancestors from limited food resources and reduced the selection pressure for a nonhuman primate type of social organization, the presence of toxins in some of the food resources of howlers may limit the population size and restrict their social organization to its present form. □

Kenneth E. Glander

Kenneth E. Glander

Adult howlers are capable of a horizontal jump of 20 feet or a vertical fall of up to 60 feet. They usually aim for a specific branch before they leap and rarely miss. Young howlers, such as the one at left, remain in constant proximity to their mothers for six months and may nurse for up to a year. Variations in the duration of nursing may affect a group's reproductive rate. During daytime rest periods, howlers frequently straddle branches, far left, remaining in the same position for up to an hour.

Masked Messages

by Ann Marie Cunningham

In ancient Korea, masked commoners satirized nobles in dance dramas, quiet forms of political protest

"In the autumn of 1962, the author witnessed what was perhaps one of the most vulgar scenes ever portrayed on a stage. In the first act, a young woman enters and, after some comic dancing . . . she suddenly pulls up her skirt, stoops down, and pretends to urinate. At that moment, a black-faced reprobate monk enters from the rear, a long rosary dangling from his neck and a wooden temple block in his hand. He spies the woman, and after she moves off, bends over the soil and pretends to sniff it, in an apparent bid to seduce her, which he eventually does. That such performances do not arouse the extreme ire of the Buddhist clergy is a never-ending source of amazement. . . ."

By his own account, Alan C. Heyman, an American specialist in Korean music and dance, was taken aback by this scene, which he saw enacted in north Kyŏngsang Province, in northwestern South Korea. The drama he watched is one part of a cycle of folk plays used by the common people of Korea to satirize their social betters and their own hard lot during that nation's feudal period, which ended less than one hundred years ago. Besides vulgar, punning dialogue and situations, this type of Korean drama also incorporates lewd pantomime; colorful, grotesque masks; brocade costumes, with long, snapping sleeves; and vigorous leaping dance steps, which further exaggerate the comical masks' features.

During March and April, a visiting troupe will present Korean masked dance drama for the first time in the United States. The performers, originally from Pongsan, a North Korean city, emigrated to Seoul in 1953, when the country was divided, and they are now sponsored by the South Korean government. Troupe members are for the most part students of traditional masked dance drama, and their performances are reconstructions of a folk custom no longer seen in the countryside. However, interest in this dance form—as part of their cultural heritage and as a contemporary form of protest—appears to be growing among Koreans. At demonstrations in Seoul, students have presented masked dance dramas, using anti-establishment innuendos to criticize the South Korean government.

In Pongsan and other regional variations of Korean masked dance drama, flutes, drums, and fiddles provide a rhythmic accompaniment and, like jazz, allow plenty of room for moving around a single theme. Steps, plots, dialogue, and jokes vary, but a vaudeville spirit and plenty of slapstick are constants. Stock characters, the victims of the play's satire, also remain unchanged: Buddhist monks who all too willingly renounce their ascetic way of life for rice wine, concubines, dance, and song; an aristocrat whose pretensions are no secret to his impish valet; a loose-living monk and a nouveau riche social climber who squabble over the favors of dancing girls. (In one version, this pair try to improve their virility by vying for a butcher's offer of bull's testicles.)

Halfway through the play, a lion (made up of two or more performers) threatens to bring the degenerate humans to a richly deserved end. But he is an Oriental cousin to Oz's Cowardly Lion: he is easily distracted, and his erstwhile victims continue to make fools of themselves. High- and low-born citizens alike tangle in the eternal triangle. A husband makes up for his lack of social prestige by being insufferable at home; a poverty-stricken wife henpecks her husband over the price of carp and eventually drives him away. In the Korean peasant's life, good humor is the only winner.

The actors' papier mâché masks —originally made of gourds, wood, bamboo, leather, cloth, or clay—furnish clues to the plays' cultural and historic origins. Their cartoonli features betray the characters' natur to the audience. Eyes pop and cros foreheads wrinkle and ripple like s sand, mouths twist, and teeth a bared in fury. Disfiguring lumps ar bumps identify regulars like th Monk with Boils (being a reprobat he may have leprosy, thought to a venereal disease) or the equally ug Pockmarked Monk, who may ha been possessed by the dreaded smal pox god.

The masks indicate that the pla have their roots in magic. Up to th sixth century A.D., ancient Kor consisted of close-knit country vi lages of 200 to 1,000 souls, wh thought themselves surrounded b scores of benevolent or maliciou gods. In such communities, the *mu dang,* or shaman, was a powerful fig ure. She—for most shamans wer women—blessed all significant vi lage events: spring plantings, Augu harvest, Buddha's birthday, we dings, and funerals. She also cure disease, communicated with th dead, cast out demons. She, and th villagers who participated in thes rites, used masks to scare demons o or to assume the form of an exorcise devil. The masks' colors represente the points of the compass: blue f east, red for south, black for north yellow for west, and white for th center. Black, representing evi came to be used for a monk's mask white was appropriate for a youn girl, and red, a powerful color (re tablets were placed in front of house to ward off plagues), stood for viril ity.

The masks' colors also signifie the five guardian gods who watc

One traditional character o masked dance drama is the party loving prodigal. His red mas and vigorous dancing symboliz drunken virility

David Burnett,

over any site. To honor these guardians, the plays, when they were performed in villages, opened with a twilight procession through bamboo groves to music based on folk songs or on shamanistic or Buddhist invocations. A bonfire would be lighted, and in an open field adjacent to a sloping hillside, the play went on until dawn, when the masks and costumes were burned, being too sacred to use again except as offerings to the gods.

At an outdoor masked dance drama at Kiung Hee University in Seoul, a student dancer, left, performs in a contemporary mask. Below, a performer prepares backstage.

Acrobats and traveling players (*kwangdae*) took the shamans' masked dances to the provincial market, where people from surrounding villages gathered every five days or so. Here, the village rites at first retained some religious significance. The market, compared in Korean folk tales to a battlefield, was a noisy place where people from all over the province, living under the protection of different spirits, crowded together in one spot. To calm their attendant gods, the *kwangdae* performed appropriate rituals before and after performances.

In the Korean market, a social as well as an economic event, masked dance drama became an entertainment, a spectacle. Male actors (in Asian drama, men frequently play all the parts) set up their small stage

David Burnett, Contact

ong snake charmers and fire
ers, fortune tellers and medicine
n hawking ginseng, boiled toad,
d serpent. Marketgoers seized
dy opportunities to drink with their
nds. Reeling out of wine houses,
y would come upon the play in
gress. Masked dance drama, like
zabethan theater, acquired a par-
pating audience whose shouted re-
ons and comments became an in-
ral part of the ribald action. Cama-
erie between audience and players
w, in part, because both occupied
lowest rung of the social ladder.

Confucianism arrived from China
he seventh century A.D., and as a
ular religion, placed the king at the
of the heap and froze everyone
ow into a rigid caste system. Sha-
ns, representative of ignorant
intry people and their supersti-
ns, sank to the lowest caste. Con-
ian scholarship was the only valid
ans of social advancement. Com-
ners could not smoke in front of
oles, and butchers, as the very
vest, could not mingle with other
linary people, much less the upper
.

In 1392, the Yi dynasty—which
lured until Japan annexed Korea in
10—came to power and adopted
nfucianism as the state religion.
e social pecking order became all
portant. Clothes made the man and
ined his position; laws governed
width of sleeves and hat brims,
e length, and style of shoe appro-
ate to each class.

Although it had no use for the peas-
try, the Yi dynasty, which was
inded by a music lover, did estab-
h a governmental post to supervise
performance of masked dance
amas at court for visiting Chinese
gnitaries. Perhaps the government
o thought that it would be useful
institutionalize the commoners'
m of protest, that allowing a pres-
re valve would forestall revolution.
asked dance drama drew a critical bead on the social polarities that eventually brought down the feudal state.

uring a Pongsan mask-dance
ama performance, the prodigal
ccessfully challenges the elderly
probate monk for the favors of
e young sorceress.

Hong

Pockmarked, boil-covered monks' masks revealed, like Dorian Gray's portrait, the unattractive side of monkish characters. For many Koreans, the term "Buddhist monk"—a clergyman dedicated to vegetarianism, celibacy, and meditation—was synonymous with "hypocrite"—a holy man who drinks in secret and keeps women on the side. As for the aristocrat, he is always a fall guy for his cheeky servant and for the outrageous butcher hawking bull intestines. He is portrayed as a bombastic peacock who holds his nose at the approach of a commoner, lovingly strokes his well-groomed beard, and shows off his scholarship by delivering quotes in Chinese. Like the monk, he is easily swayed by the dancing girls, who represent all the blandishments of the flesh. Female masked dance characters cannot seem to win: the entertainers are fair game for male passersby; the wife triumphs at the concubine's expense; the housewife, a virtuous woman in society's eyes, is her husband's drudge, and when she complains, he leaves her.

On March 13, 1976, fourteen musicians and actor-dancers of Korea's Pongsan Mask-Dance Drama Troupe will perform at The American Museum of Natural History. Tickets for the concert, which starts at 3:00 P.M. in the auditorium, may be purchased by the general public for $5.50 each at the Museum or by telephone—(212) 581-1810.

For a complete schedule of the troupe's two-month tour in other American cities, contact the sponsor, The Performing Arts Program of the Asia Society, 133 East 58th Street, New York, N.Y. 10022.

While the court's Chinese visitors were laughing at these caricatures, imperial gaiety was being underwritten by heavy taxation of the much despised and increasingly angry commoners. Unemployed farm workers organized an abortive rebellion in 1786, and royalty suspended its patronage of masked dance drama as too volatile an expression of popular ire.

By the eighteenth century, however, merchants were prospering in busy market towns like Pongsan, on the main trade route to China through the Korean province of Hwanghae. A region with particularly strong class divisions, home to aristocratic literati who had not left for Seoul when the Yi dynasty moved the capital south from Sangdo, Hwanghae probably provided broad targets for masked dance dramatic tradition. Traders, manufacturers, and provincial officials with money to spare became patrons of the plays; the silk trade provided handsome costumes; and Chinese diplomats passing through en route to Seoul had to be entertained. The sponsors often wrote plots, putting in snippets of Chinese poetry, perhaps to impress their visitors or to show off their own scholarship.

Having traveled from the villages to market to court, and back to the marketplace, masked dance drama flourished in the provinces until Japan's takeover in 1910. Initially suppressed, the plays continued as the Japanese came to appreciate them. When the Pongsan troupe moved south to Seoul in 1953, masked dance drama once again acquired official sponsorship.

In North Korea, the government has for some years been encouraging language "purification"—purging native Korean of Chinese and Japanese forms. Masked dance drama, especially if, like the Pongsan variety, it is presented in North Korean dialect, may also be part of a cultural revival in the north.

Since the traditional society it criticized no longer exists, the Pongsan masked dance drama is a historical artifact, rather than a court entertainment with overtones of social protest. In contemporary South Korea, it cannot be too vociferous a voice of political dissidence, but it does consistently manage to undercut government censorship, which expurgates all sexual references from media. Recent visitors to Seoul joke that entertainment there is like an American soap opera: everything has to do with sex, but nothing is explicit. Consequently, the country vulgarity of the masked dance drama, even as a historical artifact, is a rebellious protest against the ruling class's definition of virtue. ☐

Report from Mars

by Robert Jastrow

Although the Viking *experiments have contradictory elements, they seem to indicate that life, or some process that closely imitates life, exists on Mars today*

It was late in a midsummer afternoon on the Plain of Chryse. The sun was low in the bright orange sky of Mars. The heat of the summer day had warmed the air to −40°F, and a gusty breeze of ten knots stirred the dust. The eyes of a giant, insectlike automaton rotated slowly from side to side, surveying the desert scene. A long proboscis uncurled and reached out to scoop up a sample of the orange-red soil, then drew back within the metallic body. The search for life on Mars had begun.

The automaton had been carried to Mars by the *Viking* spacecraft in 1976 and set down at a carefully selected site on the surface of the planet, chosen for its proximity to past or present sources of water. The automaton, known as the *Viking* lander, contained instruments that could sense the presence of life in several ways. Its wide-set TV eyes offered stereo color vision to search out the fossilized remains of once-living plants or animals or to scan the horizon for signs of movement. After the sample of Martian soil had been ingested, instruments inside the *Viking* lander could test it for microbes and other simple forms of life.

But to what purpose? Why should it matter whether microbes exist on Mars? The answer has to do with man's place in the cosmos. Many scientists see life as a natural outcome of the laws of physics and chemistry; they regard the earth as an undistinguished planet circling an ordinary star; and they are confident that wherever similar solar systems exist—and there are billions in the universe—life will emerge. According to the latest findings in astronomy, our solar system is roughly five billion years old, but the universe is twenty billion years old. It follows that man is one of the younger denizens of the universe and, perhaps, far from the exalted state of other, older forms of life.

However, this conclusion depends entirely on the assumption—really no more than a wishful thought—that life is common throughout the cosmos. Yet the contrary may be true; the creation of life out of inanimate matter may require the simultaneous occurrence of so many spec circumstances that it has only ha pened once.

How can we determine wheth that is so? The discovery of life (Mars would settle the question. F if life has arisen independently on tv planets in a single solar system, must be a fairly probable event. B lions of inhabited solar systems mu surround us in the galaxy, swarmi with assorted organisms.

Why Mars? The reason is th Mars offers more earthlike conditio than any other planet in this solar sy tem. It is true that water—the quinte sential ingredient of life—is in ve short supply there, but evidence h come to light that this precious sul

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Copyright © 1977 by Robert Jastrow. Adapted from his forthcoming book, *Until the Sun Dies,* to be published by W.W. Norton & Co., Inc.

nce was once present in great ndance on the planet. Numerous seup photographs of Mars show channels that look like arroyos riverbeds carved by flash floods t occurred millions of years ago. s difficult to imagine a process er than the flow of enormous vol- es of water that could have pro- ced those channels.

urthermore, the north and south es of Mars are covered by thick s of ice that show signs of having n partly melted and refrozen sev- l times. Not only has Mars been t; it has also been warm in the past. No developments more encour- ng for predictions of Martian life ld be imagined. If life could have gained a toehold on Mars during those periods of warmth and moisture, it might have adapted by slow degrees to the harsh conditions that befell the planet later on. Of course, this life would be simple and perhaps no higher than the level of a microbe. There is no chance of finding intelligent Martians because all evolutionary progress on Mars was surely slowed down many hundreds of millions of years ago, when the planet's water supply diminished and the temperature dropped. However, the tests for life by the *Viking* lander were designed with these circumstances in mind. They should work if *any* kind of living organism exists on Mars, no matter how primitive.

The first test is based on the reasoning that all organisms known on the earth give off gases as waste products. For example, plants release oxygen as a waste product, and animals and most kinds of microbes release carbon dioxide. If the Martian soil contains organisms resembling plants, a pinch of soil placed in a chamber will produce a small amount of oxygen. If the soil contains microbes or animals, carbon dioxide will be produced. An instrument adjacent to the chamber can detect these gases.

When the test for gases was carried out in 1976, carbon dioxide was released from the soil, indicating that small animals or microbes might be living in it. At the same time, a substantial amount of oxygen appeared, suggesting that the soil might contain plant life. The carbon dioxide was released slowly and steadily over a period of several days, as would be expected from a population of microbes in the soil. The oxygen, however, came off in a burst in the first few hours of the experiment. This was a surprise, because if plants were producing the oxygen, it would be released at a slow, steady rate, like the carbon dioxide.

The rapid release of oxygen was more consistent with a chemical reaction in the soil, rather than a biological process. One theory proposed that the chemical reaction might involve

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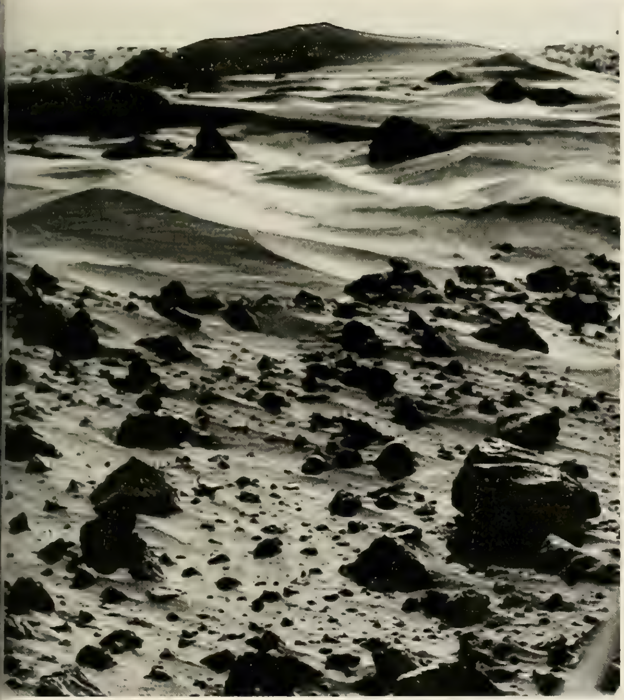


Early morning on the Plain of Chryse. The landscape is reminiscent of some desert areas of the Southwest, with sand dunes and other windblown formations and scattered blocks of volcanic debris. The large rock at the left is about three feet high and lies twenty-five feet from the Viking *lander.*

a compound called peroxide. According to this theory, solar ultraviolet radiation falling on the Martian surface would produce molecules of hydrogen peroxide, which could adhere to the grains of rock in the soil. If the grains of rock were then moistened, the hydrogen peroxide molecules would break up very rapidly into water and oxygen. Other chemical theories propose that the soil contains peroxides of calcium or metallic elements instead of hydrogen peroxides, but the end result is the same: if *any* peroxide is present, moistening of the soil releases a burst of oxygen.

Since the initial step in the *Viking* experiment was the exposure of the soil to moisture, the release of a burst of oxygen could readily be explained by the chemical reaction just described, without recourse to life processes.

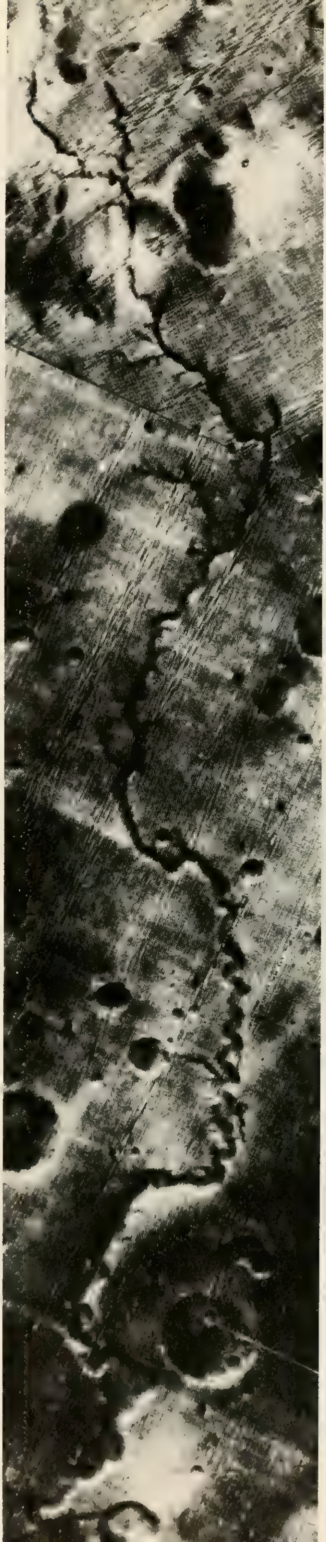
The second life test was designed primarily for microbes. In this test, another pinch of soil was placed in a chamber and moistened with a nutrient broth containing amino acids and other food substances. These substances, like all foods, were made from atoms of carbon, oxygen, nitrogen, and other chemical elements. If microbes existed in the soil, they would consume the food and digest it. Most of the atoms in the food would be incorporated into the bodies of the microbes as they grew and reproduced, but some carbon atoms would be released to the atmosphere in the form of molecules of carbon dioxide. All animals and most microbes exhale carbon dioxide in this way as a by-product of their metabolism.

How could scientists on the earth find out whether that complicated process was taking place in a chamber on Mars, more than 200 million miles away? The solution is ingenious. Before the flight to Mars, a special kind
of food had been prepared, in whi
some of the carbon atoms were t
radioactive isotope of carbon, C^{14}.
Martian microbes were present, th
would digest the C^{14} atoms and e
hale radioactive carbon dioxide.
find out if this was happening, a d
tector sensitive to radioactivity w
placed in an adjoining chamber, l
cated above the first one and sep
rated from it by a thin tube. If t
detector signaled the arrival of radi
active carbon dioxide, that wou
suggest that Martian microbes exist
in the chamber below.

When the test was carried out, t
detector indicated that a large amou
of radioactive carbon dioxide h
been produced in the pinch of s
below and had passed through t
tube into the upper chamber. Thu
this test indicated the presence
Martian life.

But the test for microbes, like t
first test, could also be explained
a chemical reaction that did not i
volve living organisms. Suppose t
Martian soil contained hydrogen pe
oxide or some similar compound,
seemed to be indicated by the relea
of a burst of oxygen in the previo
experiment. When the soil was moi
tened by the nutrient broth, the pero
ide compounds would decompose t
particles of food in the broth, brea
ing them up into smaller molecule
including molecules of carbon dio
ide. The carbon dioxide would be r
leased to the atmosphere. Some
this carbon dioxide would be radioa
tive. In that way, a purely chemic
reaction could simulate the presen
of microbes in the soil.

The third test for life was design
to detect the presence of plantlike o
ganisms on Mars. Plants require ai
water, and light for their growt
They grow particularly well in an a
mosphere of carbon dioxide, whi
happens to constitute 95 percent
the Martian atmosphere. In the expe
iment, an artificial Martian atm
sphere of carbon dioxide and wat
vapor was created in a clos
chamber, while a lamp bathed the i
terior of the chamber in a unifor
glow that imitated Martian sunligh
Presumably, a Martian plant wou
find these conditions favorable for i
growth. Next, a fresh pinch of s
was placed in the chamber. If plan
existed in the soil, they would abso



A Martian channel approximately 200 miles long, with tributaries feeding into the main "stream" and a characteristic pattern of meanders in one section, is evidence that water in abundance may once have flowed on Mars.

NASA

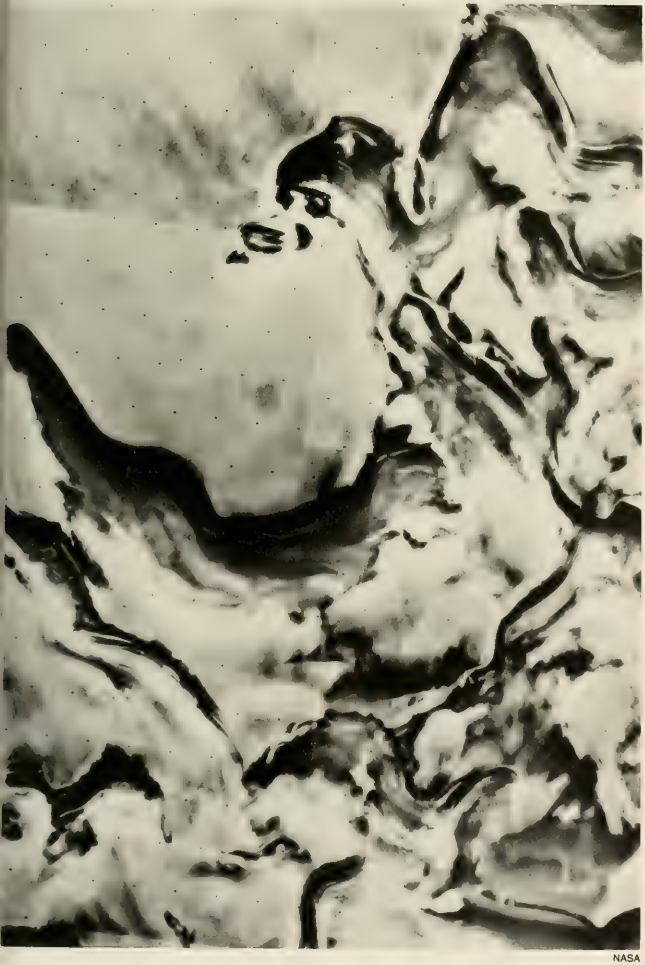
bon dioxide and water from the at- osphere; then, using the energy in artificial sunlight, they would ak up these substances and com- ne them into the compounds known carbohydrates, giving off oxygen a by-product. This complicated ocess is called photosynthesis. ome microbes also depend on pho- synthesis for energy and growth. If otosynthetic microbes existed on ars, the test would detect them too.)

The essential element in photo- nthesis is the buildup of carbohy- ates out of carbon dioxide and ater. Following the same strategy ed in the microbe test, the experi- enters decided to find out whether this was happening by using specially prepared carbon dioxide in which the carbon atoms were radioactive. Martian plants in the chamber would absorb the radioactive carbon atoms and build them into their bodies in the form of radioactive carbohydrates. If a test indicated that something in the soil had become radioactive, that would suggest that the soil contained living plants.

This test, like the other two, gave a positive result; after an incubation period of several days, the soil was found to be strongly radioactive. The implication was that it contained plants or plantlike organisms. That interpretation was supported by the fact that when the test was repeated with the artificial Martian sunlight turned off, the radioactivity dropped considerably. Apparently Martian plants, like terrestrial plants, grow more rapidly in the light.

While the first two tests can be explained by a simple chemical reaction involving peroxides, the third test cannot be readily explained in this way. Chemical theories that could explain it have been suggested, but they involve different chemical compounds and complicated reactions that have not been tested in the laboratory. Thus, a chemical explanation for this test is not as acceptable as it was for the other tests. Moreover, the chemical reactions proposed for the photosynthesis test would not be appreciably affected by the presence or absence of light; that property would be more characteristic of a plantlike biological process. These circumstances make the photosynthesis test a relatively strong item of evidence for Martian life.

Additional information came from still another experiment in which the soil was tested for organic molecules such as amino acids. Every living organism on the earth, whether plant, animal, or microbe, is made up of various combinations of these two dozen or so basic molecules. If life exists on Mars and is chemically sim-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This photograph of a 100-mile section of the north polar cup of Mars was taken on October 14, 1976, during the Martian northern hemisphere summer. A thin cover of frozen carbon dioxide, or dry ice, has evaporated, exposing underlying cakes of ordinary ice. The terraced slopes are believed to be evidence of cycles of climatic change that alternated from warm to cold perhaps every few hundred thousand years. These layers have led to a new picture of Mars as a planet currently in the grip of an ice age, but with past episodes of warmth and moisture during which conditions may have been congenial for the evolution of life.

ilar to earth life, the same familiar molecules should be present in abundance in the Martian soil. Yet the chemical experiment failed to reveal any. This result would seem to prove that life does not exist on Mars.

The photosynthesis experiment and the organic molecule test tend to cancel out one another, leaving the question of Martian life as uncertain as it was before the *Viking* lander touched down. But when all the tests for life were repeated by a second automaton, which had landed at another site 4,000 miles away, evidence against the chemical explanation was obtained and the case for biological processes was strengthened. The test for release of gases was performed again at the second site, but this time only a tenth as much oxygen was released as on the previous occasion. Since the burst of oxygen was believed to be due to peroxides, it appeared that the soil in the second landing site must contain a much smaller amount of peroxide compounds than the soil at the first site.

That discovery had a bearing on the interpretation of the microbe test. If the positive results from that test had also been triggered by peroxide compounds in the soil, one would expect the yield of "microbes" to go down when the amount of peroxides went down. But instead, when the microbe test was performed at the second site it yielded 30 percent *more* radioactive carbon dioxide than it had at the first site.

This result seems to indicate that chemical reactions involving peroxide compounds cannot be the source of the lifelike signals obtained in the

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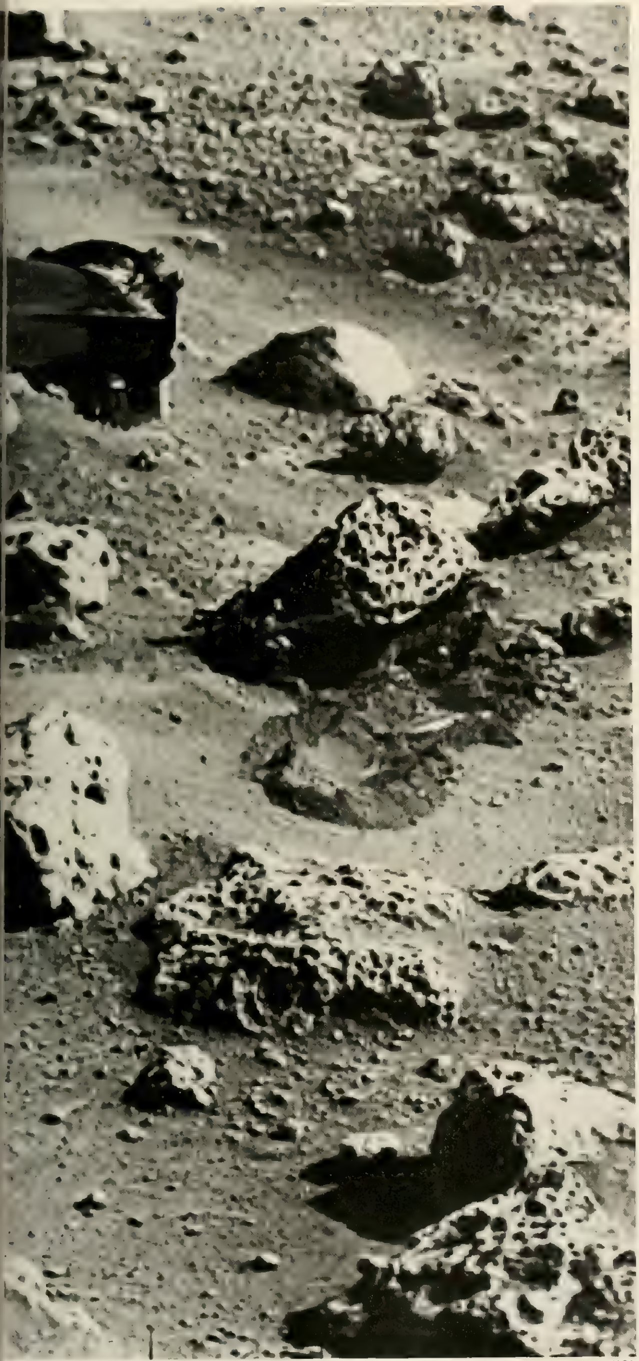
The extendable arm of the Viking *lander pushes aside a rock to get at the underlying soil, which has been protected from the destructive effects of solar ultraviolet radiation. At far right, the arm has scooped up the soil and deposited it in the lander for biological and chemical tests. The results of these tests tended to confirm the existence of Martian microorganisms.*

microbe test. With the chemical theory for that test eliminated, a biological process is the most straightforward explanation remaining.

Confirmation of the existence of Martian life would tell us that the evolution of life is a fairly easy process, one that has probably occurred in a multitude of solar systems in the cosmos. Man's views on his uniqueness would be influenced by that disclosure. With these large issues at stake, the *Viking* scientists exercised extreme caution in the interpretation of the results and carried out additional tests in an effort to discriminate between the chemical and the biological explanations for the findings. In one experiment, a rock near the second landing site was pushed aside by the boom and shovel attached to the lander and a sample of soil was collected from the region under the rock. This sample, when tested for release of gases, yielded much less oxygen than had been obtained from the surface soil sample. However, the microbe test yielded nearly as much radioactive carbon dioxide as had been obtained from the surface samples. This result confirmed the previous indication that the results of the microbe test were in fact due to microorganisms, rather than chemical reactions triggered by peroxide compounds.

In still another check, the Martian soil was heated to a temperature of 120°F, and the microbe test was repeated. Some radioactive carbon dioxide was produced although substantially less than in the test with unheated soil. This result would be expected if the soil contained a population of microbes, since their growth would be inhibited by the high temperature. However, this relatively moderate change in temperature would not be expected to have a serious effect on chemical reactions in the soil. Again the tests seemed to work against the chemical interpretation and in favor of the biological one.

An unambiguous resolution of the question of Martian life may not be obtained for decades. Nevertheless, although the *Viking* experiments have contradictory elements, they seem to indicate that life, or some process closely imitating life, exists on Mars today. ☐



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Life on a Cold Rock

Text and photographs by Fred Bruemmer

Despite miserable weather, Soviet patrols, and changeable American policy, the Eskimo of Little Diomede Island have remained hale, hearty, aloof, and the best walrus hunters around

In early summer, children at the Eskimo village of Ignaluk on Little Diomede Island grub with hope, enthusiasm, and old spoons in the mud carried down toward the beach by the spring melt. From time to time a happy yell announces a find. It is washed in the nearby sea and avidly examined. Usually it is just a bit of bone or ivory, a broken harpoon, an ancient lance. Metal pieces are usually rusted beyond recognition. A tiny brass bell has survived in better condition. Chunks of fossil ivory are handed to fathers who will carve them into bracelets, letter openers, pickle forks, and pendants. Tiny beads, usually bright blue, some of glass, some of stone—perhaps lapis lazuli—are eagerly collected.

The bell and beads came from Europe, via Siberia, centuries ago. Otto von Kotzebue, the Russian explorer, visiting these shores in 1816, was "struck . . . very much" by the great amount of glass beads and other goods from Siberia owned by the Eskimo. Now the children gather them carefully. Their mothers restring the beads. Collectors pay high prices for them.

Set in the chill and lead gray Bering Strait midway between Alaska and Siberia, usually wrapped in dismal fog and haunted by northerly storms, Little Diomede seems singularly unattractive. (During my first two months there, in spring, we had four sunny and five nearly windless days. Summer was a bit better; fall and winter, worse.) Its village sits atop a giant, frozen midden, the debris of two millennia of people who lived on this lonely rock and set forth in their skin boats, as they still do, to intercept the vast throngs of marine mammals migrating through Bering Strait each spring and fall.

Little Diomede is about 2½ miles long, 1½ miles wide, and rises steeply on all sides to its 1,309-foot summit. It is an ancient crag of granite mixed with masses of limestone that, weathered and worn, has shattered into boulders and rocks, covering many slopes—the breeding places of hundreds of thousands of seabirds. Sheer cliffs rim much of the island. Only at its northwest corner is the slope gentler, grading down to a narrow strip of boulder beach. That is where the village has been tacked against the mountainside, facing its sister island, Big Diomede (or Ostrov Ratmanova, its Russian name), three miles west and about three times bigger. Occasionally a Soviet helicopter rises from Big Diomede and flies east. After 1½ miles it halts abruptly, as if it had hit a glass wall, flies north or south along this line and returns.

That borderline, precisely in the middle between the islands, divides two worlds: Asia and America, the United States and the Soviet Union, communism and capitalism, Russia's farthest east and America's far west. It even separates today and tomorrow, for here the border coincides with the international date line. When we passed this line on our hunting trips, we moved from one day to the next and back again on the way home.

What is now a border and a barrier was once a bridge, the Bering Land Bridge, or Beringia, a vast, vanishe land. During the ice ages of the Plei tocene, immense mile-thick ic sheets covered about six millic square miles of North America an large parts of Eurasia; eight millic cubic miles of water were locke within this monstrous mass of ic The level of the world's oceans wa nearly 400 feet lower than it is now and a 1,000-mile-wide land corride connected Asia and America. Acros it from Asia came many of today North American mammals. Trave ing in the other direction were the ar cestors of the Eurasian horse and th camel.

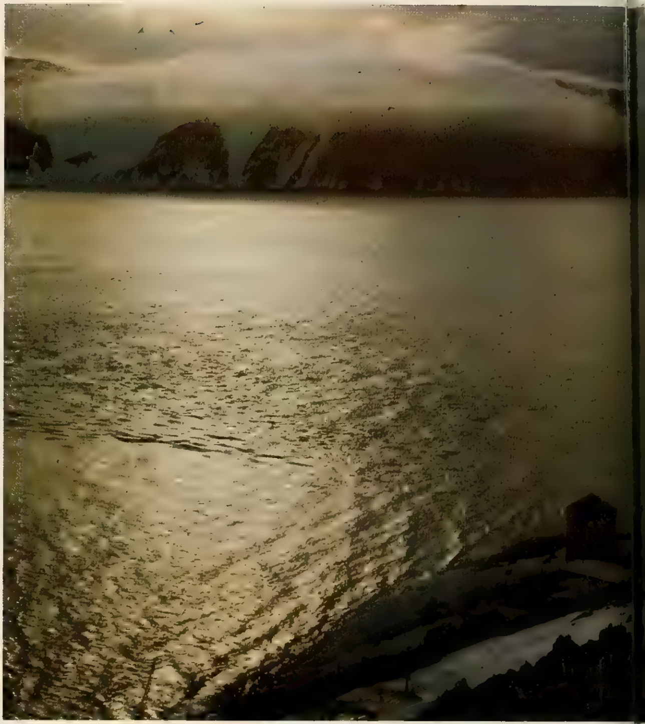
Among the last to cross the grea tundra plains of Beringia, perhap past the craggy mountains whose top today stick out of the sea as the Diomede Islands, was man, the ancesto of the Indians and Eskimo.

At the end of the last Ice Age, th ice sheets melted, releasing thei store of water and, like an Arctic Atlantis, Beringia disappeared beneat the rising sea.

Then it became Bering Strait wit the two Diomede Islands in the middle, handy stepping stones for an latecomers, who may have come i boats or could have crossed on winte ice. Bering Strait rarely freezes ove completely. The area between th

A woman cuts up walrus meat which is dried on racks for late consumption. Government subsidized houses of recent vintag (background) have replace most of the traditional shelter on Little Diomede Island

Cloud-shrouded Ostrov Ratmanova (Big Diomede Island) looms up out of the three-mile stretch of water separating it from Little Diomede (foreground). The Russian–American boundary runs between the islands.



two islands is always frozen in winter, but it is rare that both the 27-mile-wide Siberian channel and the 24-mile-wide Alaskan channel are bridged by ice floes jammed together. Yet in some years one or the other may be. Old people living on Little Diomede have made the chancy trip across the ice (one recalled that his father had done it carrying a keg of liquor), both to Siberia and Alaska.

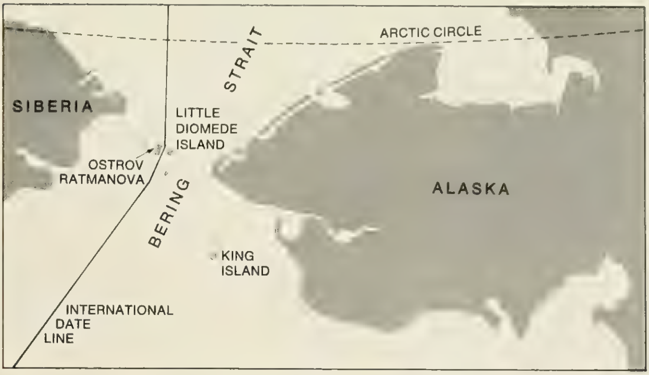
The current, rushing north through Bering Strait, carries mineral-rich waters into the shallow Chukchi Sea, the basis for an exceedingly rich planktonic and benthic flora and fauna. It is this great food wealth that each year attracts the immense migrations of sea mammals: bowhead whales, gray whales, walruses, harbor seals, bearded seals, ringed seals, and ribbon seals are common in the strait; white whales, finbacks, and humpback whales pass it occasionally. Coming from the great expanse of Bering Sea, all must funnel through the 57-mile-wide strait, making it, in spring and fall at least, one of the richest and most varied sea-mammal areas on earth, and a sort of Eden for sea-mammal hunters possessing both the equipment and the courage to pursue such large prey in a foggy, stormy, ice-jammed sea.

As the men in the middle, the Diomeders were ideally placed to exploit this marine wealth. They were always famous for their skill and daring. Even today they have no equal as walrus hunters and enjoy a slightly ambiguous reputation as "Vikings of the Arctic Sea," which they rather cherish. One day, two boat crews were in the Alaska mainland village of Wales and saw a film about Genghis Khan and the Golden Horde. Back on Little Diomede, they were asked by a visiting biologist how they liked the film. One man grinned and said, "Nothing special. Just a bunch of Diomeders on horseback!"

The Diomeders were also ideally placed to be middlemen in the once flourishing, and probably very ancient, trade between Siberia and Alaska. For people having the superbly seaworthy, large skin boats known as umiaks (a 40-foot umiak can carry more than forty people or five tons of cargo), the trip across the strait was easy. On a rare fine day, one can clearly see the Diomede Islands and Siberia's East Cape (Mys Dezhneva) from Alaska's Cape Prince of Wales, and Alaska, of course, is equally visible from the other side. Given a favorable wind, the strait could be crossed with paddles and sail in about a day. In the nineteenth century, Siberian Eskimo and Chukchi occasionally made the 200-mile trip from East Cape to Saint Michael and, quite regularly, the somewhat shorter journey to the "trade fair" in Kotzebue. When early-nineteenth-century explorers visited Alaskan Eskimo villages, they found the people well supplied with Asian trade goods.

One hindrance to even more exter sive trade was probably that the Asia and Alaskan natives did not exactl look kindly upon each other. Edwar W. Nelson, of the Smithsonian Inst tution, traveling in this region be tween 1877 and 1881, wrote that "i ancient times the people of Berin Strait were constantly at war with on another, the people of the Diomed islands being leaguered with the Es kimos of the Siberian shore agains the combined forces" of Eskim along the American side of Berin Strait. Occasionally, alliance changed, and Little Diomeder fought on the American side, agains their erstwhile allies on Big Diomed and Siberia. In 1926, when Canadia anthropologist Diamond Jenness du at Little Diomede, one of the mos common artifacts he came upon (stil found now) were rectangular ivor plates, once part of the warfaring Es kimo's imbricated body armor.

Under Russian rule of Alaska (no too popular; to this day Diomeder call a disliked white a "gussuk,"



ruption of "cossack")—from its
covery in 1741 until its sale to the
ited States in 1867—and subse-
ntly, American rule on the Alas-
side and Russian rule on the Si-
ian side of the Bering Strait, war-
gradually ceased and trade in-
ased. The 1867 treaty between the
ited States and Russia stipulates
t the border between them shall
s "midway between the island
usenstern, or Ignalook [Little Dio-
de], and the island Ratmanoff, or
onarbook [Big Diomede], and
ceed due north, without limita-
n, into the . . . Frozen Ocean."
ade between Alaska and Siberia be-
ne extensive in the nineteenth and
ly twentieth centuries and even the
e of the Red star over Siberia did
t change this. Although American
ders were banned from the Si-
rian coast, the Little Diomeders
intained their Russian connection.
arly all had relatives and friends on
th sides of Bering Strait. Siberians
ntinued to visit Little Diomede well
o the 1930s, and the Diomeders sailed blithely to Siberia whenever they felt like it, usually once a year. The Siberians then were short of trade goods but had an abundance of furs and ivory. Little Diomeders took over the needed items and returned with such valuables as white fox pelts worth (in 1927) $42 in Alaska and blue fox furs worth about $150. It was a pleasant, prosperous time.

This happy if somewhat anachronistic state of affairs came to an abrupt end in 1948 when the cold war reached the Diomedes. The Iron Curtain clanked down and two boats from Little Diomede were caught on the wrong side of it.

That summer eighteen Little Diomeders in a happy holiday spirit sailed to visit their neighbors on Big Diomede Island, only to be arrested on arrival. They were confined for fifty-two days, interrogated at length, and fed black bread and watery cabbage soup: a drastic change from their usually copious fat/meat diet. They were released only after repeated protests by Washington and returned home famished and furious; they have never really forgiven the Russians and they certainly haven't forgotten the incident. Several men joined the National Guard, prompted at least as much by pique and patriotism, as by the desire for extra income.

For nearly a quarter century the separation was total. Officially for health reasons (there had been a "flu" epidemic), but more probably to remove any temptation for clandestine meetings, Soviet authorities resettled the Eskimo of Big Diomede on the Siberian mainland coast in 1954.

Lately, however, détente has reached the Diomedes. A few years ago, Little Diomede walrus hunters in their skin boats met, near the border in Bering Strait, Siberian Eskimo hunters in similar boats and exchanged gifts, hunting information, and news of long-separated relatives and friends. Now when Diomede boats are pushed by ice, winds, and currents into Russian waters, they are checked out by Soviet helicopters, whose pilots take a good look and fly off with a friendly wave.

While I lived on Little Diomede, we were startled one spring day to see two dark dots, barely visible through the grayish veil of wind-driven snow, coming toward us across the ice from the west. Half the village piled pell-mell onto snowmobiles and raced out to meet the visitors. (The first snowmobile came to Little Diomede in 1972. Since then so many have been bought that they have replaced all dog teams.) They were Victor and Volodia, two blithe spirits in voluminous parkas and beautifully made sealskin pants, sent from a Siberian sovkhoz (state farm) to trap arctic foxes and hunt fresh meat, on a contract basis, for the Russian border guards stationed on Big Diomede.

The visitors spoke Yuit, the dialect of nearly all of Siberia's roughly 1,500 Eskimo, which is so different from the dialect spoken on Little Diomede that they could barely communicate with their hosts. They resolved the problem by speaking Russian and English, using me as interpreter. What, I wondered, did the border guards have to say about their excursion to meet the Diomeders? "Oh

PRIMO

men perform the chore of oving the thick blubber r from the hides of hly killed walruses. rus meat and fat form the s of the Diomeders' diet.

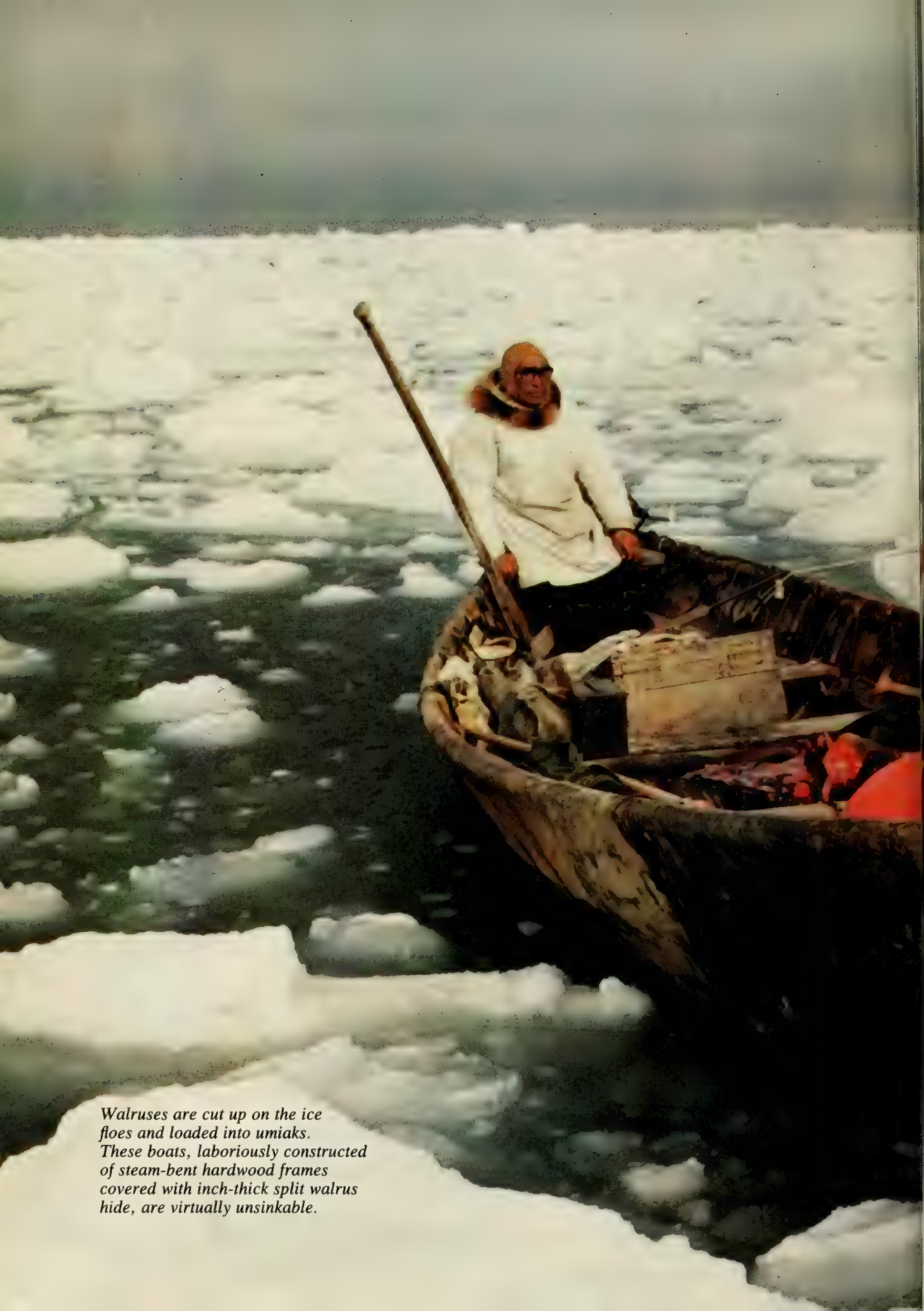
," Victor brushed them off with ave of his hand, "they don't like But what can they do? We are ters. We travel far. How can they p track of us? So they said: 'OK, and meet the people over there. t be careful. No trouble!' What trouble do they expect? These are our people. They are Eskimo, just like us." That was the dominant theme of this and frequent subsequent meetings. Whatever else divided them, they were all Eskimo, united by kinship, culture, and tradition.

At the turn of the century, when great gold deposits were discovered in the sand of Seward Peninsula beaches and Nome grew into a boomtown, Diomeders and Eskimo from King Island (40 miles south of the Diomedes) came to Nome each summer to sell ivory carvings and buy provisions. The King Islanders were eventually persuaded by the government to abandon their hard-to-service island and to settle permanently in Nome. Similar pressure was exerted on the Diomeders in the 1950s and 1960s but most refused to budge from their lonely rock. Nevertheless, a few did leave, and for a while the population decreased, from 103 in 1950 to 90 in 1960 and 84 in 1970. Since then the trend has been reversed, and in 1975 the Diomeders numbered 119. Government policy changed and new, subsidized houses were built to replace the ancient Diomede dwellings—shelters dug partially into the mountainside: the inner shell made of driftwood logs enclosed with stone walls; the roof of logs and sod (in remoter times, of walrus skin), with a skylight of scraped, translucent walrus intestine. The village received a new store and, in 1976, a new $1.5-million school. All this construction not only provided employment, luring back some of the Diomeders who had left the island, but also an added boon, abundant fossil ivory dug up as land was leveled for house sites.

"Ivory," say the islanders, "is our gold." It is the basis of Diomede economy and, to some extent, is also the island's currency. In lieu of cash, the store accepts both ivory and carvings from villagers who come to buy food, ammunition, gas, or oil. Phone calls can be paid for in cash or ivory. And on bingo nights, an expensive island passion, most cards are purchased with carvings.

Most men and several women are excellent carvers. Seated on the floor (many also prefer to eat on the floor, in the traditional fashion, with a sheet of plywood as a table), they work with speed and extraordinary assurance, turning out small walrus effigies and pendants. Many make beautiful bracelets of small ivory squares, using the ancient bow drill of bone or ivory and thong to drill twin holes through the thin (5 mm) plates. In the 1880s, Nelson had admired the Dio-

Walrus tusks are chopped out of the skulls and cleaned. Ivory is the "gold" around which the islanders' economy revolves. Many purchases are made with ivory instead of conventional money.



Walruses are cut up on the ice floes and loaded into umiaks. These boats, laboriously constructed of steam-bent hardwood frames covered with inch-thick split walrus hide, are virtually unsinkable.

ittle Diomede girl flanked wo veteran walrus hunters. t visitors to the island are ck by the general good th, strength, and vigor e inhabitants.

ers' skill: "Many of their carv- are really artistic, and the skill i which animal forms are carved elief is admirable." These old ings were often etched, the fine s smeared with a mixture of gun- der and blood, leaving a dark and nanent stain. Today, Diomeders India ink. The most skilled can day make carvings worth $100 150 to them. To a good Diomede er, a pair of medium-sized walrus s in this form represents a value 1,200 to $1,500.

ate fall and winter are quiet times ittle Diomede. New ice, dark and r sharp, and vast, jagged ice ls pressed down from the north e travel impossible. The island is pletely isolated; only in a grave rgency would an evacuation by copter be attempted. Only from uary to April is the ice near the nd firm enough for planes to land. the islanders have food in plenty. store, at this time, is usually well visioned and the families' meat es—spacious, stone-lined cav- s, some of great age, dug deep into frozen mountainside—are mmed with an abundance of food n sea and land.

he Diomeders' diet is varied, lthful, and largely traditional. lrus meat and fat, of which they e a virtually unlimited supply, m the basis. Seal oil is eaten with st meals; if a Diomeder has to go mainland hospital, he is liable to e a big jug of seal oil along because without it, he says food just doesn't taste right. It is also their main preservative. Bird eggs (mainly murre), collected by the thousands in early summer, are stored, raw or boiled, in oil and can thus be kept for about a year. Birds are preserved in meat holes or are boiled and stored in oil. Blubber is allowed to age until saffron yellow, then marinated in seal oil and eaten as a zesty condiment with the bland boiled meat or with *kauk* (boiled walrus skin), which is best after it has aged in a meat hole for about a year. A dubious-looking delicacy is "sour liver," raw walrus liver kept in a large wooden dish near a stove for a few weeks until it turns into a brownish liquid. It has a piquant, somewhat vinegary taste; one uses it as a sauce to enhance the boiled meat that usually forms the main course.

The Diomeders collect and eat a great variety of greens, stems, roots, seaweed, and berries. In the past, they obtained much of their vegetable food on Big Diomede, where it is more abundant than on their own small island, and they are annoyed that they can no longer visit there. With small mattocks they dig up the corms of spring beauty, which look like tiny potatoes. These are boiled and eaten with meat or mashed with seal oil (or occasionally, reindeer fat bought on the mainland) into a pleasant, if somewhat bland, paste. After the frequent storms, women and children collect the thin, narrow, iodine-rich fronds of seaweed washed up on the beach, dry them, and eat them raw (they have a nice, salty flavor) or mix them with soups and stews. Willow shoots and young leaves, ten times richer in vitamin C than oranges, are collected in early summer and eaten either fresh or, like other greens, preserved in seal oil for future use.

Salads are made from the radish-flavored leaves of Kamchatka rock cress, the sourish leaves of mountain sorrel, and the leaves of Parry's wallflower, which grow in tight, bright green rosettes on the mountainsides and contain considerable quantities of vitamin C and provitamin A. In fall, great quantities of cloudberries are gathered on the moist, plateaulike island top; when kept frozen in pokes (plastic bags are now used) in the meat holes, they retain their high vitamin C content for up to one year.

Diomeders tend to be finicky about their food and have a host of rules and recipes on how to prepare, serve, and preserve it; as a result, meals are usually varied, copious, interesting, and probably very nutritious and healthful. Most visitors have remarked on the Diomeders exceptionally strong and vigorous appearance. "The natives . . . look sturdy," noted anthropologist Ales Hrdlicka in 1926. "None other could survive here."

Their survival and success, now as in the past, depends on their hunting skill and daring, and on their superlative skin boats. They have seven umiaks, four 30-foot ones, used for walrus hunting and long journeys, and three 18-foot ones, used primarily in early spring to hunt bearded and ringed seals among the drifting floes near the island. Two frames (now of steam-bent hardwood, formerly of driftwood) were built in 1974 (it takes a man about three weeks to construct a frame); the others are old, one is more than thirty years old but still strong. They are covered with split walrus hide. The two-inch-thick hides of female walruses or young bulls are cut into two inch-thick halves, a slow and exacting job left to the women. Several hides (five for a big umiak, three for a small one) are sewn together, stretched over the frame, and lashed onto it with walrus thong, which anthropologist Froelich Rainey has called "the strongest line known before the invention of the steel cable." A yard-broad waistcloth of canvas (formerly sealskin) is furled against the gunwale in calm seas, and raised on paddles and poles around the boat as a spray guard in a storm. The keel is shod with the smooth, fine-grained bone of a whale's jaw to glide easily across the ice. (The newest boats use split vinyl hose for this purpose.)

Until fairly recently, the Diomeders paddled their umiaks and, in addition, used a simple square sail of seal or caribou skin, with grommets and blocks carved of ivory. In storms, inflated sealskins were lashed to an umiak's side as sponsons. "With their boats fitted in this manner these people sail fearlessly along their stormy coasts," Nelson noted in the 1870s. They still do, only now they usually use 40 h.p. outboard motors,

e arrival of migratory seabirds May—when nesting begins— ngs a halt to education on island. Children hunt the birds h slingshots during the bright hts and tend to sleep in school.

with a spare 25 h.p. motor in the boat in case of trouble. In these boats the daring Diomeders, regarded by the meeker mainland Eskimo with respect bordering on awe, will set out in nearly any weather, in storm and fog and racing ice. They claim the umiaks are virtually unsinkable, and considering the risks they routinely take, this must be true because they have never lost a boat. The frame is strong but flexible, the cover extremely tough. Occasionally, an enraged walrus rips a cover, but the men, prepared for this eventuality, plug the hole with chunks of blubber, continue the hunt, and when time permits, haul the umiak onto a floe and patch it with pieces of hide.

They carry mariners' compasses, but fog, strong currents, and the zigzag course of hunting often make it difficult to find Little Diomede again, since the island is such a small target. They fire shots, hoping for a shore echo, study the flight of birds, and watch the drift of ice. If none of this provides a clue to their whereabouts, they turn the motor off to conserve gas, and drift, sleeping, huddled up on the thwarts, in the damp chill that seems to seep to one's very core, hoping the fog will lift. As a last resort, they head east, for as they say, "You can't miss the mainland."

Spring starts quietly. The men carve or hunt seals at the floe edge, the limit of landfast ice, usually not more than a mile or two from the village. Women and children spend patient hours "crabbing" at holes chiseled through the ice, catching crabs that measure, including spindly legs, about two feet in diameter (northern cousins of the famous king crabs). The method is simple. A stone sinker and two chunks of fish as bait are lowered on a thin line to the sea bottom. A feeding crab, loath to lose food, hangs on as it is pulled gently upward. Only when it is nearly at the surface does the crab seem nervous and loosen its grip, but by then it is usually too late. The most patient crabbers, using several lines, can catch twenty or thirty crabs in a day. Others jig for tomcod and sculpins through leads in the ice. Both are popular for fish soup.

In May, the migrant animals arrive and pass, by sea and air. Some 20,000 sandhill cranes and a quarter million snow geese, which have wintered in the United States, fly across Bering Strait to their breeding grounds in Siberia, and the luminous Arctic night is filled with their loud and urgent calls. From Asia, flocks of small birds come to breed in Alaska: wagtails, arctic warblers, and wheatears. Once, while we were lost in fog and drifting north into the Chukchi Sea, an exhausted wheatear, as lost as we, landed on our boat. Everyone took care not to alarm the little passenger, and he remained with us until we came within sight of the mainland.

In May, too, the seabirds arrive to nest on Little Diomede: hundreds of thousands of sparrow-sized least auklets, tens of thousands of crested a
lets, pelagic cormorants, mur
tufted puffins, and pigeon guillem
In the evening and at night, when t
whir around the island, their myr
excited calls blend, filling the air w
a strange, persistent, pulsating no
The arrival of the birds marks, for
practical purposes, the end of
Diomede school year. The child
are on the mountain all night,
sleep blissfully in school. Us
slingshots with elastic bands, they
many birds, a few windows, and
casionally, each other. For a wh
the village has its share of walk
wounded. An island law forbids, w
good reason, the use of the anci
thong slings within a mile of the

. Except when used by an expert, ng slings tend to be erratic and can leadly.

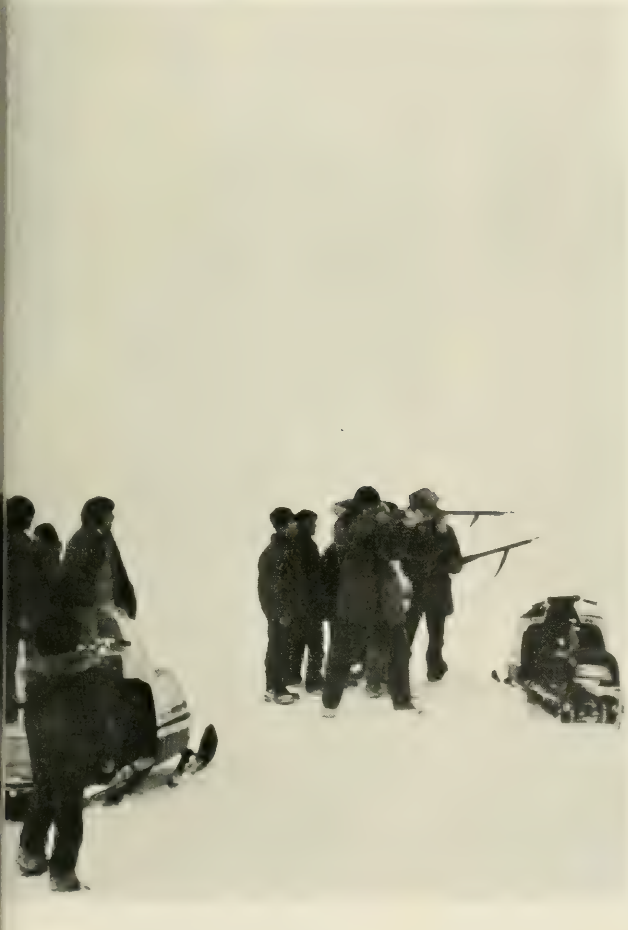
he men haul the small umiaks oss the ice to the floe edge near the h end of the island and hunt rded seals and ringed seals among drifting, swirling, grinding floes ıe pack. When nipped by ice, they l the umiak onto a floe and ride ıg until the pressure eases and / can find a way through the floes. ales pass, but they are rarely pur- d. By tradition and inclination meders are primarily walrus hunt- Walrus are numerous now. Once ıced by commercial walrus hunt- to a population of 40,000 or less, animals have increased again in recent decades to about 150,000. When the walruses arrive, the Diomeders switch to their large umiaks and the big hunt of the year is on. June, on Diomede, is called "the month when people do not sleep."

The four walrus-hunting boats, each with a crew of from eight to twelve men (ranging in age from 16 to well over 60), vie with each other to be best. Often they return just long enough to unload a cargo of meat, hides, and ivory, pick up more gas, and head out again. The hunt is expensive. In gas alone, it costs $30 to $40 each day (this, as well as most of the food, is supplied by the boat captain, but his share of ivory is increased to make up at least a part of this cost), and the crew may spend $20 a day each on ammunition. The boat captain usually consults with his crew during the hunt, but his is the final say. Most of the men have hunted together for years; in the risky race among drifting ice and enraged walruses, they work as a skilled and expert team.

And then, suddenly, it is all over. The last great bull walruses, bringing up the rear of the migration, have passed. The large racks at Diomede are crowded with slabs of drying meat; the meat holes are full. The crews divide the ivory and the baculums, or penis bones, which sell for nearly $100 each in Nome. (Baculums, about 1½ feet long, are much sought after by tourists as conversation pieces.) The men rest and relax. They catch birds on the mountain with long-handled nets, a technique identical to the one used by the polar Eskimo of Greenland, nearly 4,000 miles to the east. They rappel down the sheer cliffs to collect eggs or "go egging" to Fairway Rock, a murre-crowded pinnacle twelve miles southeast of Little Diomede. They have a great hunger for greens; men, women, and children swarm over the mountain with plastic bags, collecting leaves and tender shoots. The weather is finally warm, the living easy.

Nevertheless, within a few weeks, most will leave the island: to stay in Nome or Anchorage, to visit relatives in Seattle or Los Angeles, to work on the pipeline. They will be gone for two or three months. But in September, when storms lash the sea, they return to their island like birds flocking to an ancestral roost.

There is a brief fall hunt when the walrus return, but it is rare that many animals are taken. The ice returns from the north, autumn gales screech over the strait, and the Little Diomeders again are isolated on their lonely rock between two worlds. ☐



Siberian and Alaskan Eskimo meet on the border between the Soviet Union and the United States and try out each other's guns. Détente has reached this area of the Bering Strait.

Misleading Mantids

Text and photographs by George F. Rohrmann

Both predator and prey are often deceived by false appearances

Flowering plants made their appearance among the earth's flora about 100 million years ago; their debut coincided with the evolution of a host of insect pollinators. Some 60 million years later, the ancestors of today's mantids evolved, preying upon flies, bees, wasps, butterflies, and moths associated with flowering plants. The mantids, believed to have descended from a carnivorous cockroach, occupied a niche created by the presence of flowering plants and their insect fauna. They have developed into some of the most efficient predators of flower-visiting insects, rivaling such voracious arthropods as crab spiders and robber flies.

In order to capture flower-visiting insects and avoid detection by other insectivorous predators, such as birds, lizards, and small primates, elaborate concealment mechanisms have been selected for among the mantids. A study I conducted on mantids in Swaziland, a subtropical African country, revealed a great variety of such mechanisms, based mainly on camouflage. A number of behaviors, including startle displays, attack, and active escape, were also used, in conjunction with camouflage, as defenses against some mantid predators.

Cryptic coloration is the basic mechanism by which mantids conceal themselves from prey and predators. The most common colors are green and brown, which match the vegetation in much of the mantids' habitat. Some species show polymorphism with regard to color and have a mixed population of brown and green individuals. These colors appear to vary seasonally: brown is more common during dry periods; green more prevalent during the rainy season. One species, *Pseudocreobotra wahlbergi,* changes its color to yellow, brown, green, blue, or white depending on the color of its immediate surroundings. This permits first instar nymphs to associate with a variety of different colored vegetation. Once having found a suitable location (normally a flower), a nymph will usually remain there until its final molt at the age of seven or eight months. As the flower's color changes with the season, the nymph does likewise. In the dry season when the flowering plant has died, the nymph turns a matching brown.

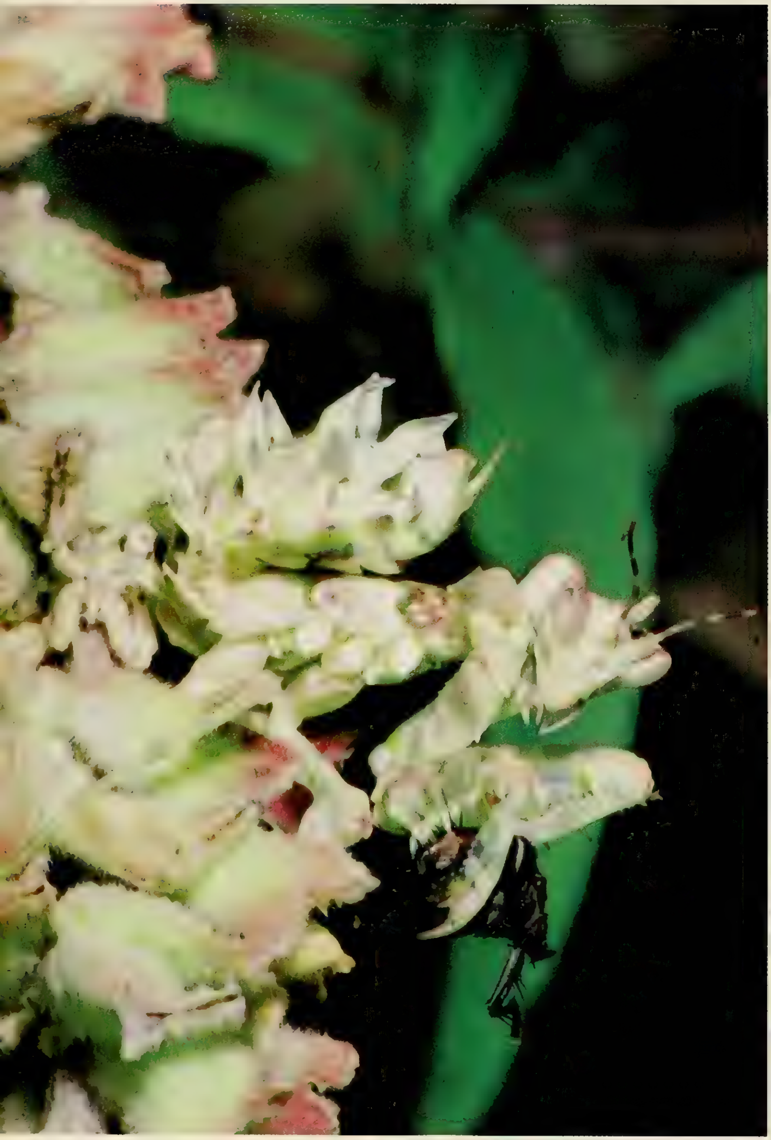
Anatomical structures that resemble parts of plants are another mechanism for concealment that has evolved in mantids. The physical appearance of many smaller mantid species is similar to a blade of grass, a shape that helps them blend with grassy vegetation. Another adaptation is a body structure resembling a stick or twig. The concealment value of this shape is enhanced by the mantid's behavior. When disturbed, the mantid stretches into an elongate position, with the tibiae of the forelegs folded back against the femora and held in front of the head. The mantid bends its antennae backward against its body so that they are concealed. When a mantid hangs upside down, the visual effect is that of a forked twig (with the middle and hind legs resembling side branches), a resemblance further enhanced by the ba
like texture of the mantid's cuticle

Many groups of mantids mim
leaves. In some species the nymph
leaflike abdomen is flexed over t
thorax. When the nymph is disturbe
it flattens its body and directs its abd
men toward the source of the distur
ance. The combination of outlin
color, and superficial structure of t
abdomen contributes to its leaflike a
pearance. Looking like closely ass
ciated leaves, smaller nymphs fr
quently sit on the edge of a flower a
ambush visiting insect pollinators.

Both the nymph and adult stages
some species have dark patches
their cuticles, giving them the appea
ance of aged or diseased leaves. *Phy
locrania paradoxa* has elaborate e
pansions on its legs, abdomen, a
head, and its wing tips are curled a
colored to resemble a dead leaf.

Floral mimicry is a method of co
cealment characteristic of *Pseud
creobotra wahlbergi.* The nymph
this species possesses spines on th
underside of the abdomen, whic
when observed in the flexed positio
effectively imitate the clustered r
productive structure of a flower. Th
nymph perches on the petals of
flower with its flexed abdomen
close association with the stame
and pistils. Incoming insects attemp

*Resembling, in both color a
structure, the dead grass
which it is clinging, a Sou
African mantid,* Pyrgomant
rhodesica, *is hidden fro
both prey and predator*



The first instar nymph of Pseudocreobotra wahlbergi *exhibits color change and floral mimicry. It is able to adopt the color of a number of different flowers. When one particular flower is chosen, the nymph remains in association with it, changing color along with the flower in the latter's progression from full bloom to death. The nymph's flexed spines imitate the flower's reproductive structures and act as a deadly lure to pollinating insects.*

› pollinate the flower may instead tracted to, and often easily cap- l by, the disguised nymph.

aying mantids exhibit other ; of structural concealment adap- ns that are not dependent on a mblance to vegetation. The y hatched nymphs of many spe- are similar in size, structure, and vior to ants and this is thought to predation during this stage of development. One mantid, *ilus nasutus,* has body mark- that strongly suggest that its phal form resembles bird drop- s.

ther protective mechanisms, in- ing structural and color modifi- ns, direct a predator's attacks y from the most vulnerable parts mantid's body. Bright yellow kings on the mid-forewings of e species could cause a predator ttack the wings rather than the l. Since mantids do not depend on t to capture prey (the females of y species are incapable of flight n laden with eggs), damage to area would not affect their ability irvive as much as damage to other y parts.

a some mantid species, startle dis- s have evolved to discourage lators. These coordinated groups ctions are initiated at the approach potential predator and result in artling change in a mantid's ap- ance. An integral part of a startle lay is the coloration, normally visible, on the underside of a ntid. The color pattern often in- les black or blue eyespots on the r side of the tibia; in some species d "pupil" on a black background es as the eyespot. During the dis- , the mantid rears up on its four l legs, angles out its front legs, oses the eyespots, and elevates its it wings, creating an illusion of eased size. A side-to-side sway- motion and a hissing sound pro- ed by rubbing the dorsal part of abdomen against the hind wings often incorporated into the display, adding to the threatening attitude of the disturbed mantid.

Such startle displays have been observed to discourage lizards, small primates, and cats who have detected the mantid despite its concealment mechanisms. If the startle display fails, the mantid is likely to strike out with its forelegs in an attempt to fight off an attacker. If everything else fails, a mantid will beat as hasty a retreat as possible.

Startle displays are more typical of the larger mantid species, which are clumsy and readily captured if they attempt a simple escape. Smaller mantids generally move faster and are more easily obscured by vegetation. These species normally do not produce startle displays nor do they attempt to fight off attackers.

Although camouflage and adaptive behavioral patterns protect mantids as nymphs and adults, the developing embryos are extremely vulnerable to predation. The female mantid lays her eggs in an elaborate ootheca composed of foamlike, proteinaceous membranes that harden upon drying. Attached to the branches of trees and shrubs, oothecae come in a variety of shapes depending on the species of mantid. Female chalcid wasps are capable of identifying an ootheca and use their long ovipositors to deposit their eggs within its chambers. The wasp eggs develop at the expense of the mantid embryos; in some instances no mantids will hatch. If any mantid embryos do survive, and hatch concurrently with the wasps, the tables are turned and the young wasps become the mantid nymph's first meal.

Mantids—an estimated 1,500 species confined largely to the warmer regions of the world—have succeeded in exploiting the association of flowering plants and insects. The range of adaptations present in mantid populations reflects the character of the vegetation in their environment. In contrast to Swaziland, for example, many areas of Africa such as the Kalahari Desert receive only brief seasonal rains and are covered with sparsely foliated bush and grass. Their mantid populations lack the variety of floral mimicry of species from wetter climates; however, they show an equally diverse array of adaptations to the bark, twigs, and stems that are the most prevalent plant components in arid regions. ☐

en threatened, some mantids use artle display as defense. In version, a mantid sways from : to side and makes a hissing nd by rubbing its second pair vings against its abdomen.

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Twin-engined Spaceship Earth

Because of its size, earth is atypical among the inner planets of our solar system

Charles Lyell expressed in no uncertain terms the guiding concept of his geologic revolution. In 1829, he wrote to his colleague and scientific opponent Roderick Murchison:

> My work . . . will endeavor to establish the *principle of reasoning* in the science . . . that *no causes whatever* have from the earliest time to which we can look back, to the present, ever acted, but those now acting; and that they never acted with different degrees of energy from that which they now exert.

The doctrine of slow, stately, essentially uniform rates of change had a profound influence on nineteenth-century thought. Darwin adopted it thirty years later, and paleontologists ever since have been searching for cases of slow and steady evolution in the fossil record. But what was the origin of Lyell's preference for gradual change?

All cosmic generalizations have complex roots. In part, Lyell merely "discovered" his own political prejudices in nature—if the earth proclaims that change must proceed slowly and gradually, encumbered by the weight of events long past, then liberals might take comfort in a world increasingly threatened by social unrest. Nature, however, is not merely an empty stage upon which scientists display their prior preferences; nature also speaks back. Many of the forces that shape the surface of our planet do act slowly and continuously. Lyell could measure the accumulation of silt in river bottoms and the gradual erosion of hillslopes. Lyell's gradualism, while far too extreme in his formulation, does express a large part of the earth's history.

Our planet's gradual processes arise from the action of what my colleagues Frank Press and Raymond Siever call the external and internal heat engines of the earth. Our sun powers the external engine, but its influence depends on the earth's atmosphere. They write:

> Solar energy drives the atmosphere in a complex pattern of winds to give us our climates and weather, and it drives the ocean's circulation in a pattern that is coupled to the atmosphere. The water and gases of the oceans and atmosphere chemically react with the solid surface and physically transport material from one place to another.

Most of these processes work gradually, in a classic Lyellian manner; their large results are an accumulation of minute changes. Running water wears the land away; dunes march over deserts; waves destroy the coastline in some places, while currents transport sand to extend it elsewhere.

Heat derived from radioactive decay powers the internal engine. Some of its results—earthquakes and volcanic eruptions, for example—strike us as sudden and catastrophic, but the basic process, discovered only a decade ago, must be a source of joy for Lyell's shade. Internal heat puts the earth's surface in motion, driving the continents apart at minute rates of centimeters per year. This gradual motion, extended over 200 million years, has separated the single land of Pangaea into our present, widely dispersed continents.

Yet our earth is decidedly atypical among the other inner planets of our solar system: Mercury, Mars, and our own moon. (I exclude Venus because we know almost nothing about its surface; only one Russian probe has successfully penetrated its dense atn
sphere to send back but two ambi
ous photos. I also exclude Jupiter a
the large planets beyond. They are
much larger and less dense than
inner planets that they belong to
very different class of cosm
bodies.) No geologist, no matter h
strong his prior preferences, co
have preached a doctrine of unifor
ity on the surface of any inner pla
except the earth.

Craters made by meteoritic bo
bardment dominate the surfaces
Mars, Mercury, and our moon.
deed, the surface of Mercury is lit
more than a field of tightly packed a
superimposed craters. The moo
surface is divided into two ma
areas: densely cratered highlands a
the more sparsely cratered ma
("seas" of basaltic lava). Lyelli
gradualism, so applicable to
earth, cannot possibly describe t
history of our planetary neighbors.

Consider, for example, our moo
history, as inferred from data c
lected during the *Apollo* missions a
summarized by Columbia Universi
geologist W. Ian Ridley: The moo
crust rigidified more than 4 billi
years ago. By 3.9 billion years ag
the greatest period of meteoritic bo
bardment had ended, the mare basi
had been excavated, and the maj
craters formed. Between 3.1 and 3
billion years ago, radioactively ge
erated heat produced the basaltic la
that filled the mare basins. Then t
generation of new heat failed
match its loss at the lunar surface a
the crust rigidified; by 3.1 billi
years ago, the crust became too thi
to permit the ascent of any more b
salt, and activity at the lunar surfa
essentially ended. Since then, not
ing much has happened beyond t
very occasional impact of a lar

by Stephen Jay Gould

orite and the constant influx of
small ones.
e view the moon today much as
oked 3 billion years ago. It has
tmosphere to erode and recycle
aterial of its surface, and it can-
enerate the internal heat to churn
nd change its visage. The moon
t dead, but it is certainly quies-
The concentration of moon-
es at 800–1,000 km below the
ice suggests a rigid crust of this
kness, compared with 70 km or so
he earth's lithosphere. (To con-
kilometers to miles multiply by
1.) A partially molten zone may
below the lunar crust, but it is
ar down to influence the surface.
moon's surface is ancient, and its
rd is the story of its catastro-
—massive meteorites and up-
ing lava. Its early history was
ked by violent change; its last 3
on years by very little indeed.
hy is the earth so different from
eighbors in recording a history
ked in large part by cumulative
ual processes, rather than ancient
strophes? Readers might be
pted to think that the answer lies
ome complicated difference in
position. But all the inner planets
asically similar, so far as we can
in density and mineralogical con-
. I wish to argue that the dif-
nce arises from a disarmingly
ple fact—*size itself, and nothing*
: the earth is a good deal larger
its neighbors.
alileo first discussed the cardinal
ortance of size in determining the
n and operation of all physical ob-
s (see my columns of January and
ruary 1974). As a basic fact of
metry, large bodies are not sub-
to the same balance of forces as
ll objects of the same shape (all
nets are, necessarily, roughly

Actual Size: 23.9mm (15/16") dia.
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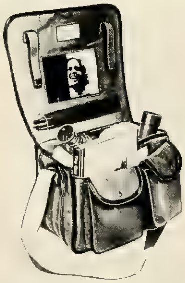

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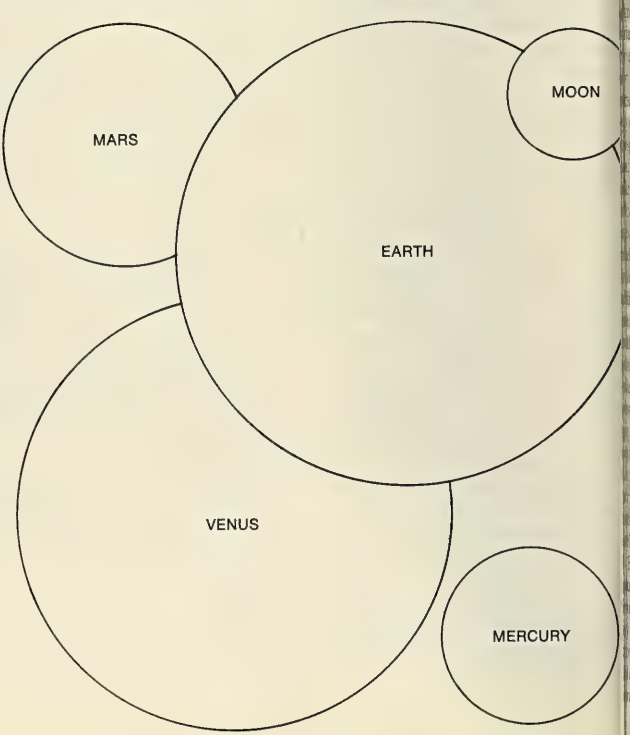
spherical). Consider the ratio of surface to volume in two spheres of different radii. Surface is measured by a constant times the radius squared; volume by a different constant times the radius cubed. Hence, volumes increase faster than surfaces as objects of the same shape become larger. This simple principle explains an astonishing array of disparate phenomena. Why can flies, but not people, walk up walls? (Small animals have enormously greater ratios of surface to volume than we do; forces of surface adhesion acting on a fly's feet are relatively great, while gravitational forces acting on its weight are negligible.) Why are all the largest birds flightless? (Lift must be generated by the surface area of wings, while the body's weight increases as the cube of its length—don't believe the giant ants of *Them* for a minute.)

I maintain that Lyell's insight is a contingent result of the earth's relatively low surface/volume ratio, not a general characteristic of all change, as he would have argued. We begin by assuming that the earth's early history did not differ much from that of its neighbors. At one time, our planet must have been scarred by abundant craters. But they were effaced billions of years ago, destroyed by the earth's two heat machines: churned up by internal machine (uplifted in mo tains, covered by lava, or burie the depths of the earth by subduc at the descending borders of li spheric plates) or quickly oblitera in atmospheric or fluvial erosion the external machine.

These two heat machines ope only because the earth is large eno to possess a relatively small surf and large gravitational field. Merc and the moon have neither at sphere nor an active surface. The ternal machine requires an atmosph for its work. Newton's equation lates the force of gravity directly the mass of two bodies and invers to the square of the distance sepa ing them. To calculate the force ho ing a molecule of water vapor at surface of the earth or moon, we n only consider the mass of the pla (since the mass of the molecule constant) and the distance from planet's surface to its center. A planet gets larger, its mass increa as the cube of its radius, while squared distance from surface to c ter is simply the radius squar Hence, as a planet gets larger, its g vitational pull on a potential atn spheric particle increases as r (where r is the planet's radius.



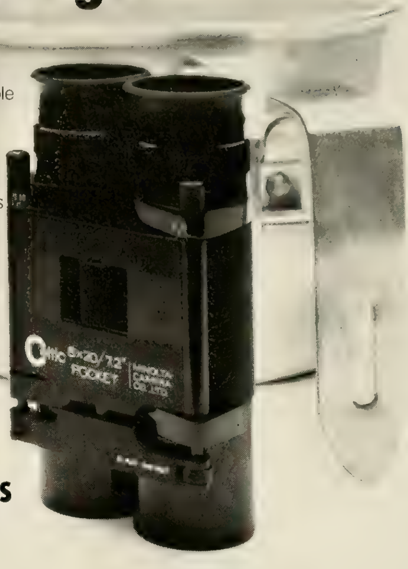
noon and Mercury, the gravita-
ıl force is too small to hold an
osphere; even the heaviest par-
s do not abide long. The earth's
ity is sufficiently strong to hold
ge, permanent atmosphere to act
medium for its external heat ma-
e.

ternal heat is generated radioac-
y over the volume of a planet. It
diated out into space at a planet's
ace. Small planets, with their
ratio of surface to volume,
kly lose their heat and solidify
outer layers to relatively great
hs. Larger planets retain their
and the mobility of their sur-
s.

he ideal test for this hypothesis
ld be a planet of intermediate
, for we predict that such a body
ld display an intermediate mix of
erved early catastrophes and
lual processes. Mars, obligingly,
st the right size, nicely interme-
between the earth and our moon
ercury. About half of the Mar-
surface is cratered; the rest re-
s the activity of rather limited in-
al and external heat machines.
tian gravity is weak compared to
of the earth, but it is strong
ugh to hold a slight atmosphere
ut 200 times thinner than ours).
h winds course over the Martian
ace and dune fields have been ob-
ed. The evidence for fluvial ero-
is even more impressive, if
ewhat mysterious, given the pau-
of water vapor in the Martian at-
phere. (The mystery has been
h alleviated by the discovery that
s's polar caps are predominantly
en water, not carbon dioxide, as
iously conjectured. It also seems
ly that a considerable amount of
er lies frozen as permafrost in the
tian soil. Carl Sagan has shown
photos of relatively small craters
lobate extensions in all direc-
s. It is hard to interpret these fea-
s as anything but liquefied mud,
ing away from the crater follow-
localized melting of permafrost
n impact. They cannot represent
because the meteorites that
ned the craters were too small to
erate enough heat on impact to
t rock.)

vidence for internal heat is also
ndant (and rather spectacular),
le some recent speculation plausi-
links it with the process that
ves the earth's plates. Mars has a
canic province with giant moun-
s surpassing anything on earth.

Easy on the go.



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Olympus Mons has a base 500
wide, a height of 8 km, and a cra
70 km in diameter. The nearby Va
Marineris dwarfs any canyon
earth: it is 120 km wide, 6 km de
and more than 5,000 km long.

Now, the speculation: Many ge
ogists believe that the earth's pla
are moved by plumes of heat and m
ten material rising from deep wit
the earth (perhaps even at t
core–mantle boundary, 3,200
below the surface). These plum
emerge at the surface at relativ
fixed "hot spots," and the eart
plates ride over the plumes. The H
waiian Islands, for example, are
essentially linear chain increasing
age toward the northwest. If the P
cific plate is slowly moving over
fixed plume, then the Hawaiian
lands might have been formed one
one.

Mars, with its intermediate siz
should be more dynamic than t
moon, less so than the earth. T
moon's crust is too thick to move
all; internal heat does not reach t
surface. The earth's crust is th
enough to break into plates and mo
continuously. Suppose that the cru
of Mars is thin enough to allow he
to rise, but too thick to break up a
move extensively. Suppose also th
plumes exist both on the earth a
Mars. Giant Olympus Mons may re
resent the locus of a plume, risi
under a crust that cannot move-
Olympus Mons, if you will, may
like all the Hawaiis, piled one at
the other. The Vallis Marineris m
represent an unsuccessful "try"
plate tectonics—the crust fracture
but could not move.

Science, at its best, is unifying.
strikes my intellectual fancy to lea
that the principle regulating a f
on my ceiling also determines th
uniqueness of our earth among th
inner planets. Pascal once remarke
in planetary metaphor, that know
edge is like a sphere in space; th
more we learn—that is, the larger th
sphere—the greater our contact wi
the unknown (the planet's surface
True enough—but remember th
principle of surface and volumes! Th
larger the sphere, the greater the rat
of known (volume) to unknown (su
face). May absolutely increase
ignorance continue to flourish wi
relatively increased knowledge.

*Stephen Jay Gould teaches biolog
geology, and the history of science
Harvard University.*

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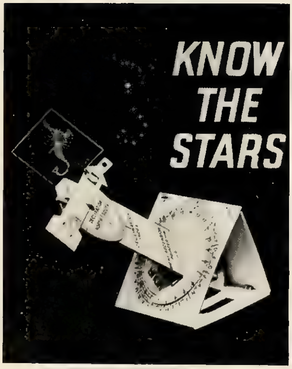

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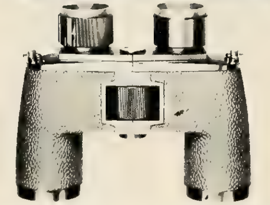

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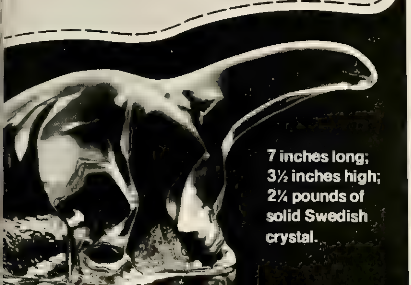

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The greatest photographic competition in the history of *Natural History* is on. The Grand Prize is a round trip for two to Peru, a country that will challenge any photographer with vistas of ancient royal cities, Andean peaks, Amazonian jungles, deserts, fog-shrouded coasts, and a colorful mixture of peoples. The cash prizes this year total more than $3,000. And the winning entries will be published in a special double issue of *Natural History* in August and will be shown at The American Museum of Natural History.

Culver Pictures

The four categories for entries are broad enough to fit the interests of any photographer because *Natural History* is concerned primarily with receiving and publishing great photographs. The categories are: (1) The Natural World; (2) A Sequence of an Event in Nature; (3) Microphotography, including pictures with a scanning electron microscope; and (4) The Human Family. First pri in each category is $500. In addition, these awards will be selected from all the entries: Humor in Nature, $200; Urb Wildlife, $200; and ten Hono able Mentions at $100 each.

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The Rules

1. The competition is open to everyone except employees of The American Museum of Natural History and their kin.

2. Competitors may submit up to three previously unpublished entries in each of the four categories. Decision of the judges is final.

3. The Museum acquires the right to publish, exhibit, and use for promotion the winning photographs. The Museum assumes no responsibility for other entries.

4. Entries may be transparencies or prints up to 8 by 10 inches, and each must bear the photographer's name and address.

5. Enclose a self-addressed, stamped envelope for the return of entries.

6. Entries must be postmarked no later than April 15, 1977.

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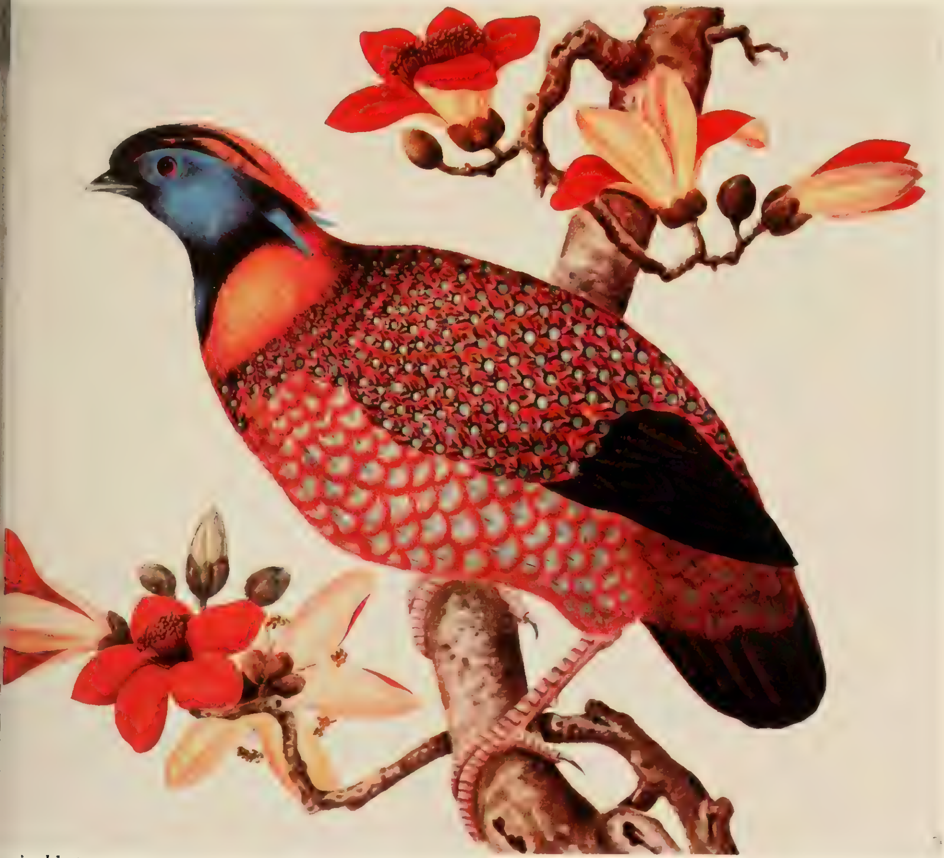
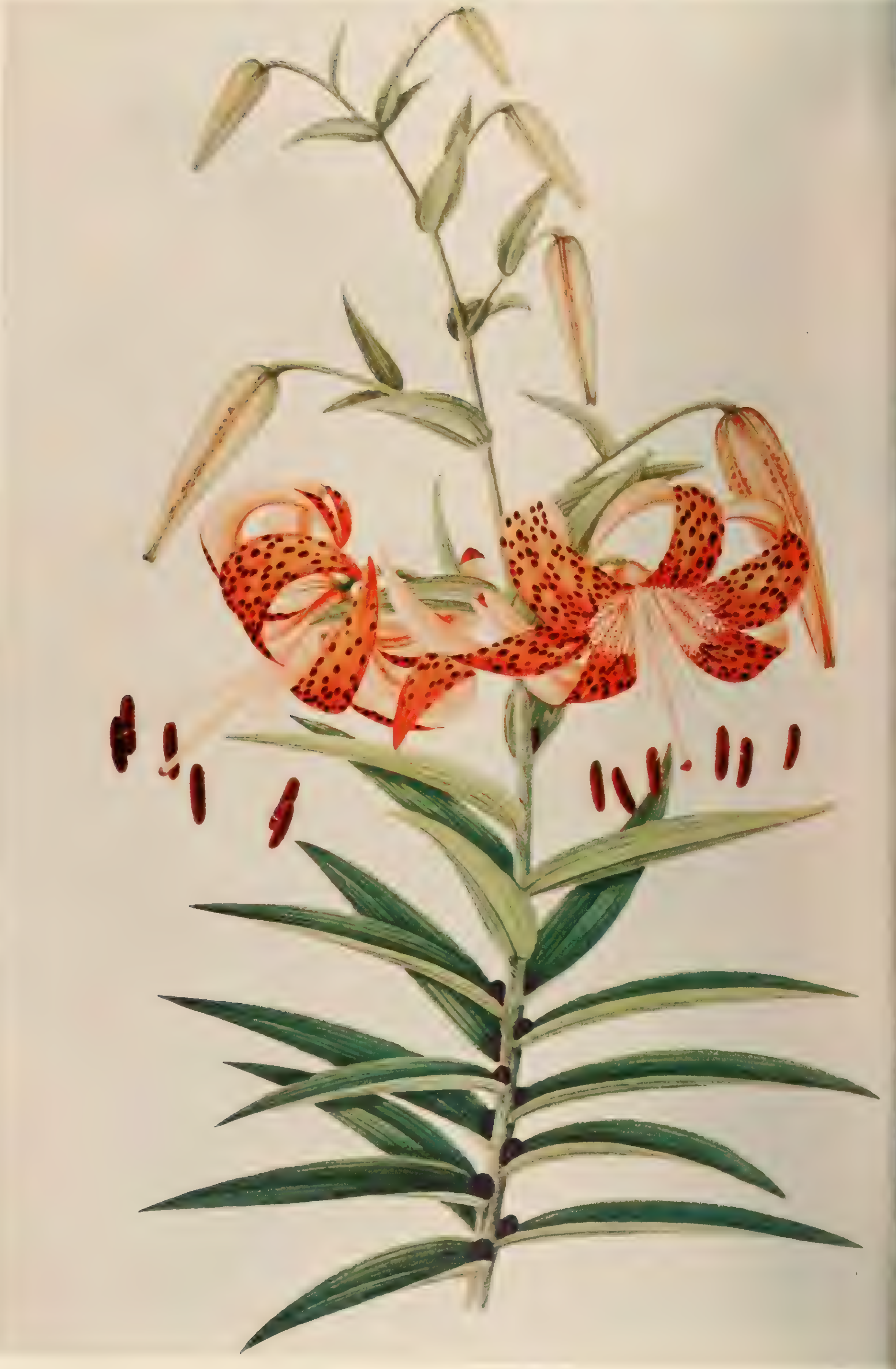
Reeves joined the East India Tea Company and went to China in 1812. At that time very little was known of the natural history of China, and Reeves began sending specimens of mammals, reptiles, and birds to the British Museum and plant specimens to the Horticultural Society of London. As a further method of recording the exotic fauna and flora of China, Reeves conceived the idea of commissioning scientifically accurate drawings for the Horticultural Soci-



minck's tragopan



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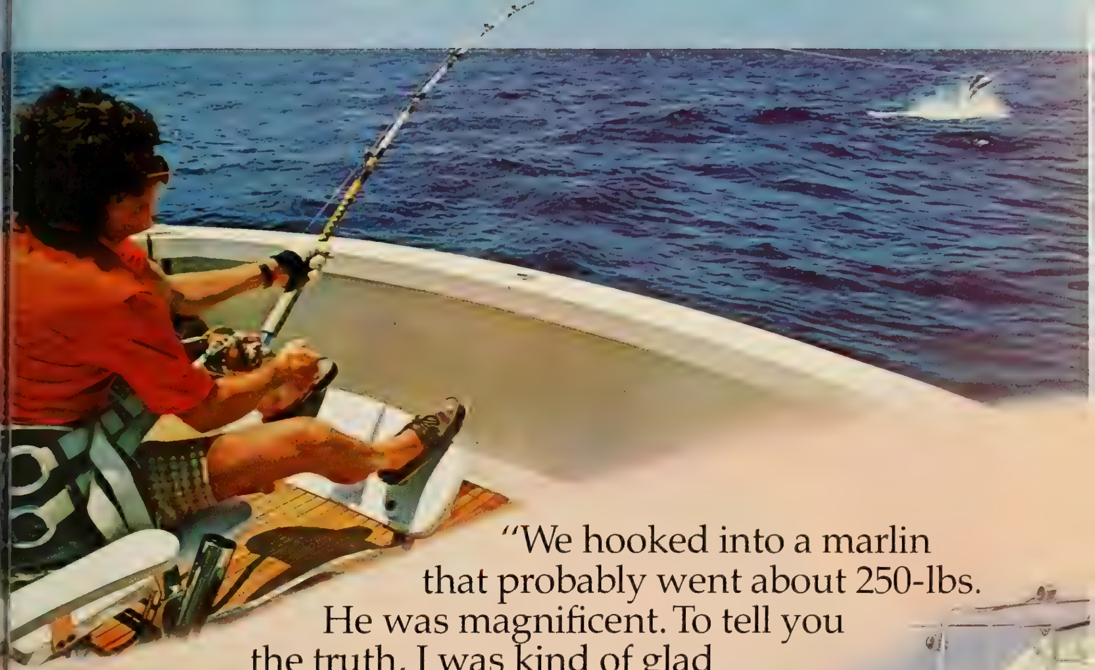

"We hooked into a marlin
that probably went about 250-lbs.
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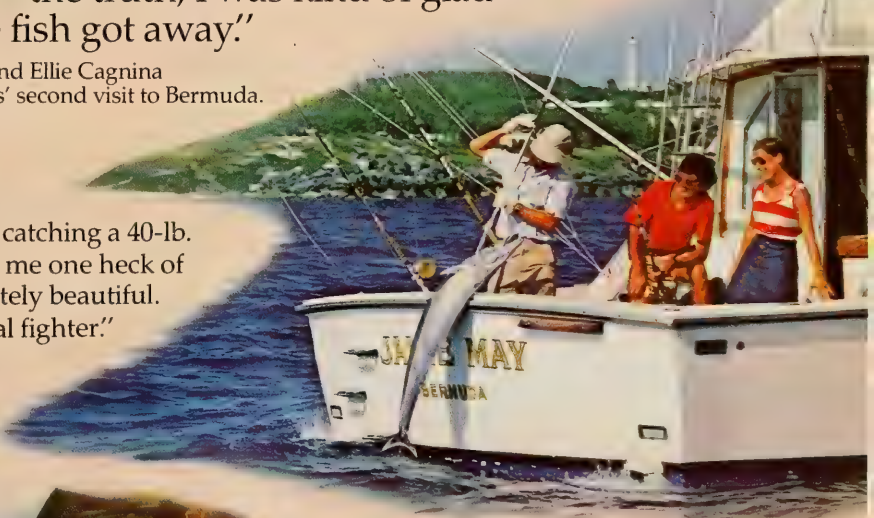
the truth, I was kind of glad
the fish got away."

Bob and Ellie Cagnina
on the Cagninas' second visit to Bermuda.



"We ended up catching a 40-lb.
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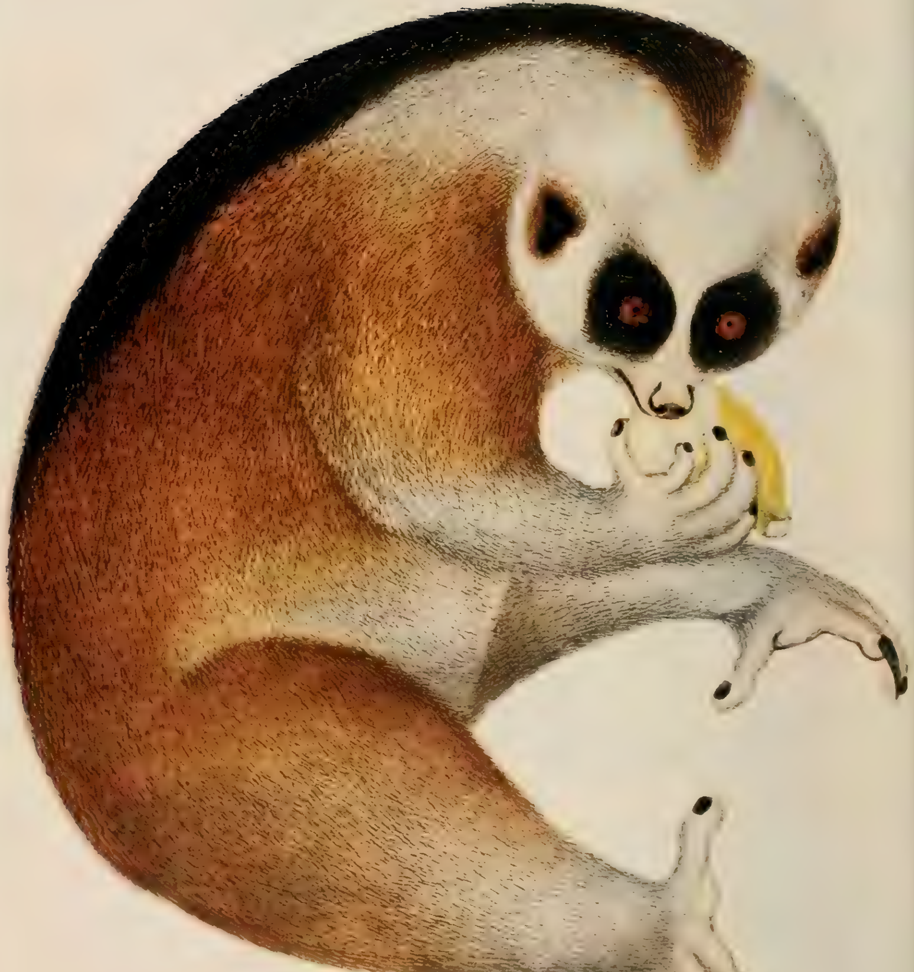

Slow lor

y which agreed to pay the modest of the Chinese artists. The draw- penciled on large sheets of and then colored with water- paints, ranged in subject matter plants and mammals to insects sh. Many were accurate enough in describing new species and were of plants that were com- ly unknown in Europe.

e beauty and scientific impor- of these watercolors has pre- ly been confined to those few access to the collection in the sh Museum. But now, in a large- at, limited-edition volume, ty of these outstanding artistic s have been reproduced to give pling of both animal and botani- bjects, with an introductory text ding the historical background collection. To do justice to the ate work of the artists, the paint- were reproduced by the Collo- process, a printing method e great flexibility achieves an al- exact color match and even re- uces the finest details of the origi- enciled drawings underlying the rcolors.

Carol Breslin

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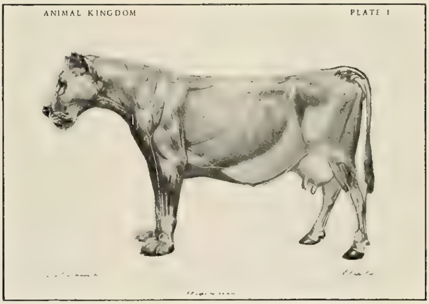

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A Matter of Taste

Strange Fruits

Hurrah for the tasty aliens trying to make it on these shores!

Last Sunday I dined on stewed kiwi at the home of a lonely gold-digger.
Walter Buller
Birds of New Zealand (1888)

In Buller's day, a kiwi was always a bird, a flightless bird with a Maori name. Scientists might call it *Apteryx,* New Zealanders might adopt it as their nickname, and a shoe polish manufacturer might take kiwi for his logo and his trade name. But none of this exploitation of a long-beaked fellow creature disguised the fact that a kiwi was a bird. Indeed, the only untoward piece of kiwi lore, until recently, was that Buller would, despite professional ethics, eat one.

Today, if I announced to up-to-date company that I had been fed a kiwi by a solitary gold digger, eyebrows would rise. My audience would assume that I had supped, not with a sourdough, but with a vamp. And these days, everyone who is anyone knows that a kiwi is a fruit.

Until 1906, and probably for some time afterward, this furry, brownish-green, ovoid, three-inch-long delicacy bore the humble name of Chinese gooseberry. It grew first in the valley of the Yangtze in China. Its electric green, tart flesh tasted roughly like a European gooseberry. Thus Chinese gooseberry was a logical name, and it did the job for everyone except scientists, who dubbed it *Actinidia chinensis* (they knew that it wasn't a true gooseberry and didn't belong in the gooseberry genus *Ribes*), and merchandisers in New Zealand, who apparently didn't think Chinese gooseberry was a selling name. The merchandisers, at some point after 1906, when the plant was introduced to New Zealand, chauvinistically renamed it kiwifruit.

New Zealand is still the only country that has grown kiwis on a commercial scale. They could be grown in the south of our country, but they aren't. And so Americans pay as much as 70 cents per fruit. This s
price has helped to make kiwifı
chic. They are also stunning to
at when peeled and sliced so that t
delicate, edible black seeds gliste
an inner ring within a gorgeous g
field. The French culinary av
garde has gathered *les kiwis* to
bosom (see recipe below). And e
American supermarkets have be
selling kiwis as a specialty item.

The kiwi is only the latest ex
fruit to enter the American marke
joins a distinguished successior
luscious hybrids and tropical tr
plants, ranging from the avocad
the mango. Some of these tasty al
have never really caught on.
cherimoya (*Annona cherimola*)
the Andes has been cultivated h
but a leading New York fruiterer
ports that he sees them "maybe c
every fifteen years, and they co
from Hawaii or New Zealand.
have never tasted the reportedly s
betlike flesh of the cherimoya, b
would pay dearly for the chai
Mark Twain called the cherim
"deliciousness itself." Tropical h
ticulturist Wilson Popenoe quote
even more expansive opinion fro
botanical colleague named Seem

> The pineapple, the mangosteen and
> cherimoya are considered the finest fr
> in the world. I have tasted them in th
> localities in which they are suppose
> attain their highest perfection—the p
> apple in Guayaquil, the mangosteen
> the Indian Archipelago, and the ch
> moya on the slopes of the Andes—ar
> I were called upon to act the part of P
> I would without hesitation assign
> apple to the cherimoya. Its taste, ind
> surpasses that of every other fruit,
> Haenke was quite right when he calle
> "the masterpiece of Nature."

You will find equally dithyram
accounts of the mangosteen (*G*
cinia mangostana), a native of M
laysia and Indonesia unrelated to
mango, in the works of the dis
guished botanist David G. Fairch
(1869–1954). He was the father
tropical plant introduction in
United States and organized the
fice of Foreign Seed and Plant In

by Raymond Sokolov

ion (SPI) for the Department of iculture in 1898. Fairchild was in nental in the establishment of the ida and California avocado in ries. Between 1898 and 1912, he SPI bring in more than 30,000 nct varieties and species of ign plants. At its peak, in 1916, was receiving forty distinct plant ns a week from abroad.

orld War I brought an end to, or ast lessened official interest in, t introduction. Fairchild kept the n, however, and continued to cul te his own exotic garden in Coco Grove, Florida, where he settled his wife, Marian, the daughter lexander Graham Bell.

he Fairchild Tropical Garden was blished there in 1938, with 400 ical trees. And Fairchild continued to propagandize for his beloved mangosteen, while serving guests such home-grown transplants as the alamoen, a natural tangelo from Surinam.

Meanwhile, Fairchild's favorite student, Popenoe, had planted a mangosteen orchard for United Fruit at Lantecilla, Honduras. The slow-maturing trees now reportedly bear fruit, but they are not exploited commercially. And it looks as though Fairchild's dream will not come true even in this generation.

Somewhere along the line, the steam went out of the tropical fruit introduction movement. In addition to wars and depressions, the plant hunters also ran up against unforeseen horticultural complications. Popenoe's optimism about the cheri-

iwi

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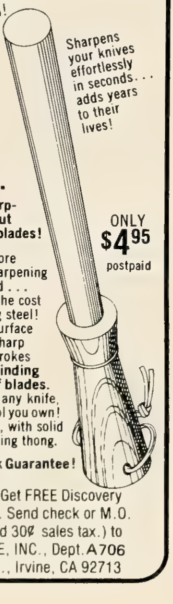

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moya in 1920 yielded, four decades later, to resignation, for experimentation had by then shown that the plant's climatic requirements were precise. It had to be grown where the air was neither too hot nor too dry. Otherwise, if it did grow, its flowers had to be expensively and laboriously hand pollinated. Popenoe and Fairchild could look proudly on firmly rooted grapefruit and soybean industries. But they—and we—must lament a host of lost opportunities. Perhaps they are really opportunities not yet seized. At any rate, join me in this plea to the fruit industry, for mangosteens and cherimoyas, for baels, carissas, ramontchis, and ketembillas.

Meanwhile, while we are waiting for them, we ought to salute growers and distributors who buck the overwhelming trend toward limiting the variety of fresh produce in our markets. Hail to the Florida orchards that bring us fresh litchis in midsummer. Hail to the tangelo men. Hail to the green thumbs behind the fragrant pear-apple. And a friendly salute to the kiwifruit importers. I wish some enterprising American would plant them and bring the price down. But even now, who can resist. If only the Indonesians would wise up and send us a few mangosteens. . . .

Kiwi Tart

Based on an idea of the Restaurant Troisgros, Roanne, France.

Short piecrust dough for a single crust, 9-inch pie
Dry beans
2¼ cups heavy cream
2 eggs
½ cup sugar
3 tablespoons kirsch
7–8 kiwis, peeled and sliced crosswise and about ½ inch thick

1. Set a 9- to 10-inch flan ring on a baking sheet. Roll out the dough and press it onto the ring. Trim around the top edge. Line the inside of the crust with a layer of aluminum foil and fill the foil with enough beans to weight it against the bottom and sides of the crust. Refrigerate for an hour or more.
2. When ready to bake the tart, preheat oven to 400 degrees.
3. Simmer the heavy cream (which preferably should not be ultrapasteurized) until it is reduced by half, to approximately 1 cup plus 2 tablespoons.
4. Mix together the cream, the eggs,

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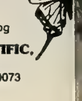

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1 tablespoon of sugar, and the kirsch, until very well blended.

5. Bake the crust with the beans for 10 minutes. Remove from oven and reduce heat to 350°. Remove foil and beans. Arrange the kiwi slices over the crust and cover with the egg-cream custard mixture. Bake for 20 more minutes or until custard has set. Remove from oven.
6. Preheat broiler.
7. Sprinkle the remaining sugar evenly on the top of the tart. Run under the broiler until beads of caramel begin to form.
8. Let cool. Then slide the tart onto a serving platter, remove the ring, and serve.

Yield: 8 servings.

Kiwi Cream

Adapted from *Kiwi Cookbook*, by Alan Armstrong, Seven Seas Publishing, Wellington and Sydney, 1968.

- 2 eggs, separated
- ⅛ teaspoon salt
- 1 tablespoon cornstarch
- ½ teaspoon vanilla extract
- 1 cup scalded milk
- ½ cup sugar
- ¼ cup heavy cream, whipped until stiff
- 3 kiwis, poached in simmering water for 10 minutes, peeled, and pureed in a blender
- 1 raw kiwi, peeled and thinly sliced for garnish

1. Beat the yolks together with the salt, cornstarch, and vanilla extract until smooth.
2. Stir in the milk and cook, in a heavy saucepan over medium heat, until thick. Stir constantly during this process and as soon as thickening takes place, stir in ¼ cup of the sugar.
3. Beat the egg whites until stiff. Add the rest of the sugar gradually and continue beating until smooth.
4. Fold the whites into the yolk mixture along with the whipped cream and the kiwifruit pulp.
5. Pour the kiwi cream into a serving bowl. Decorate the surface with kiwifruit slices. Chill.

Yield: 4 servings.

Raymond Sokolov's most recent cookbook is The Saucier's Apprentice, *a guide to French sauces.*

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Ritual Enemas

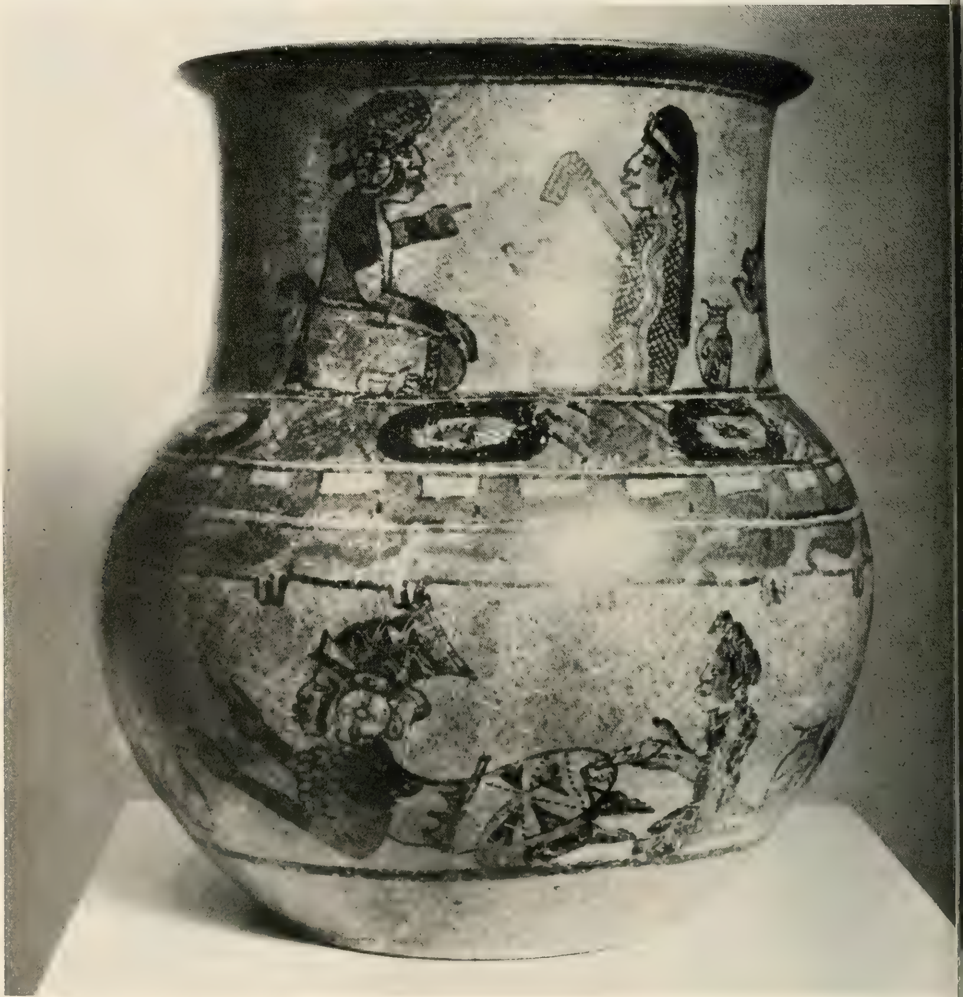
by Peter T. Furst and Michael D. Coe

The reexamination of a classic Maya vase has solved an intriguing mystery about this complex society

When the Spaniards conquered Mexico in the sixteenth century, they were at once fascinated and repelled by the Indians' widespread use not only of alcoholic beverages but also of numerous hallucinogenic plants. From the Spaniards' point of view, however, both served the same purpose—to conjure up visions of demons and devils and to take imbibers from their daily life to supernatural realms.

Distillation was unknown in the New World before the conquest, but Mesoamerican Indians were making, as they still do, a variety of intoxicating ritual drinks, principally by fermenting cactus fruit; agave, or century plant, sap; or maize ker
Among the Maya, the ritual beve
was balche, made from ferme
honey mixed with a bark extract
the balche tree, *Lonchocarpus*
gistylus. These concoctions wer
taken orally.

But according to a Spanish w
known only as the Anonymous
queror; the Huastec people of n
ern Veracruz and southern Tam
pas had pulque (fermented a



Peter T. Furst

"squirted into their breech,"
ning that they used intoxicating
nas. There are indications that the
cs, as well as several other Mes-
rican groups, also followed this
ice.

esoamerican Indians generally
liquor only on sacred occasions,
n, according to such sixteenth-
ury observers as Bishop Diego de
la of Yucatán, the Indians often
k themselves into states ap-
ching oblivion. Similarly, the
f many botanical hallucinogens,
described by Fray Bernardino de
gún and his contemporaries, was
tly limited to occasions when
t communication with the other-
d was required. Today, the best
vn of these is peyote, *Lopho-*
a williamsii, a small, spineless
us native to the north-central
rt of Mexico and southern Texas.
plant now serves as sacrament for
000 adherents of the Native
rican Church and also plays an
ortant role in the religious life of
Huichol Indians of western Mex-
Before the conquest, peyote was
ely traded throughout Mexico,
re the Aztec priests numbered it
ng their important magical and
licinal plants.

t the time of the conquest the
ls of the white-flowered morning
y *Rivea corymbosa* were a widely
l hallucinogen. In 1960, Albert
mann, the Swiss discoverer of
) (a synthetic hallucinogenic
g), isolated the active alkaloids in
morning glory species and a re-
d species, the purple- or blue-
vered *Ipomoea violacea,* and
nd them to be lysergic acid deriva-
s closely resembling LSD-25.
latter species is often referred to
"heavenly blue" in the United
tes.

s Maya vase was made more
n 1,300 years ago in what is now
atemala. Its explicit paintings
eal how the ancient Maya
ninistered hallucinogens.

Mushrooms also played an important role in preconquest Mesoamerican Indian life. Certain species, most of them now known to belong to the genus *Psilocybe*, were perhaps the most extraordinary natural hallucinogens in use in Mexico. The Aztecs called them *teonanácatl*, or "God's flesh." Psychedelic fungi were widely employed in Mexico when the Spaniards came, and their use in divination and supernatural curing survives to this day in central Mexico, as well as in the state of Oaxaca (*see* "Drugs, Chants, and Magic Mushrooms," *Natural History*, December 1975). The Indians even used tobacco to induce ecstatic trance states, which the Spanish only saw as diabolic communication.

While Spanish writers of the sixteenth and seventeenth centuries left us relatively detailed accounts of the use of hallucinogens in central Mexico, there is little mention of this intriguing aspect of native religion among the Maya, who lived farther to the south. The silence is the more puzzling because we have circumstantial evidence of a very early cult of sacred mushrooms in the Maya highlands of Guatemala and the adjacent lowlands, in the form of more than 250 mushroom effigies made of carved stone, many dating to the first millennium B.C.

The Maya were an integral part of Mesoamerican civilization and shared many of its basic assumptions about the nature of the universe and the relationship of humans to the natural and supernatural environment. Like the central Mexicans, they divided the cosmos into upperworlds and underworlds with their respective gods, believed in the cyclical destruction and regeneration of the earth and its inhabitants, and followed the 260-day ritual calendar.

In view of these many similarities, as the Maya scholar J. Eric Thompson has written, it was hard to believe that the Maya did not use intoxicating plants. Thompson searched the pages of sacred traditional books of the Yucatec Maya, set down in the European alphabet in the colonial period, for hints of ecstatic visionary trances through which the priests made their prophecies. In the *Books of Chilam Balam* (jaguar-priest) of Tizimín and Maní, he found mention of trancelike states but no hint whatever of any hallucinogenic plants. He also discovered scattered scenes in Maya relief sculpture that suggested visionary experiences characteristic of hallucinogenic ritual.

This is slim evidence, however, compared with the data from central Mexico, and some Maya scholars are not convinced that the Maya practiced the kinds of ecstatic shamanistic rituals or vision quests with botanical hallucinogens that played so pervasive a role in central Mexico, or among the Zapotecs, Mixtecs, Mazatecs, and other peoples of Oaxaca.

The silence of Spanish colonial writers on the subject of hallucinogenic plants or rituals among the Maya accords well with the view, once widely held among scholars, that the Maya were quite unlike their Mexican contemporaries in temperament, being less preoccupied with warfare and the Dionysian excesses than with the contemplative interpretation of the heavens and the passage of time. But the discovery at Bonampak, Chiapas, of mural paintings that depict, among other events, a fierce battle among Maya warriors, indicates that this traditional view is very wide of the mark.

As specialists have more closely examined Maya art and iconography in recent years, they have accumulated increasing evidence that among the classic Maya, ecstatic ritual was important. One suggestion for this is that some of the major Mexican hallucinogens—among them the morning glories and the hallucinogenic mushroom *Stropharia cubensis*—occur in the Maya country. These and other psychedelic plants were undoubtedly known to the Maya.

Had Maya specialists looked more closely at the earliest dictionaries of the Quiché and Cakchiquel languages, compiled in the first centuries after the conquest of highland Guatemala, they would have discovered mention of several varieties of mushrooms with hallucinogenic properties. One is called *xibalbaj okox* (*xibalba* means "underworld," or "land of the dead," and *okox*, "mushroom"), said by the sixteenth-century compiler to give those who eat it visions of hell. If the association of this species with the Maya underworld left any doubt of its psychedelic nature, it is dispelled by a later reference to the same species in Fray Tomas Coto's dictionary of the Cakchiquel language. According to him, *xibalbaj okox* was also called *k'aizalah okox*, which translates as the "mushroom that makes one lose one's judgment." Still another fungus, *k'ekc'un*, had inebriating characteristics, and another, *muxan okox*, apparently brought on insanity or caused one to "fall into a swoon."

We have recently come across a wholly unexpected use of psychoactive substances among the Maya—the ritual use of intoxicating enemas, unmistakably depicted in classic Maya art of the first millennium A.D., but not mentioned either in the colonial or the modern literature. This practice is well documented among the inhabitants of South American tropical forests as well as among the Inca and their contemporaries in the Andes, where archeologists have discovered enema syringes.

Sixteenth-century sources describe the Incas as regularly intoxicating themselves with infusions of *willka*, now known to be the potent hallucinogenic seeds of the acacialike *Anadenanthera colubrina* tree. Lowland Indians also used tobacco enemas.

South American Indians were the first people known to use native rubber tree sap for bulbed enema syringes. While medical enemas had a long history in the Old World, having been used by ancient Sumerians and Egyptians, as well as by Hindus, Arabs, Chinese, Greeks, and Romans, the rubber bulb syringe was unknown in Europe until two centuries after the discovery of the New World.

The native Amerindian enema was distinguished from its Old World counterpart in that its primary purpose was to introduce medicines and intoxicants into the body, while the Old World enema was employed principally to clear the bowels. During the seventeenth and eighteenth centuries, the enema as a relief for constipation, real or imagined, became a craze in Europe—so much so, that Louis XIV had more than 2,000 enemas administered to him during his reign, sometimes even receiving court functionaries and foreign dignitaries during the procedure.

The wide dissemination of the intoxicating enema in South America suggests the discovery by Indians that the rectal administration of intoxicants could radically alter one's state of consciousness more rapidly, and with fewer undesirable side effects, such as nausea, than oral administration. The physiological reason is simple: Substances injected into the rectum enter the colon, the last segment of the large intestine; the principal function of the large intestine is the reabsorption of liquids into the system and the storage of wastes until they can be evacuated. The absorbed liquid immediately enters the bloodstream, which carries it to the brain. An intoxicant or hallucinogen injected rectally closely resembles an intravenous injection in the rapidity of its effects.

The first evidence that not only the Huastecs, whose language is related to the Maya languages, but also the classic Maya knew of and employed the intoxicating enema came to light this past year through the examination of a painted vase in a private collection in New York. This polychrome jar, with a high, vertical neck and flaring rim, was probably painted in the heavily forested Petén district of northern Guatemala during the classic Maya phase, which dated from the third century A.D. to the first decades of the seventh century. Seven male–female pairs, the women easily distinguished by their robes and long hair, are depicted in two horizontal rows. That one woman is fondling a child suggests a familial setting. The activity being portrayed would have brought blushes to the cheeks of the traditional Maya specialist, for while one man is inserting a syringe into his rectum, this delicate task is being carried out for another male by his consort. One male also has a bulbed enema syringe tucked into his belt.

Nine vases, identical in shape to the actual vessel, are painted between the couples, and painted dots at the mouth of each represent a foaming, fermented liquid that is probably balche, the common alcoholic drink among the Maya at the time of the conquest. We must conclude that the people on the vase are taking intoxicating enemas, a practice previously unrecorded for this culture.

An understanding of the scenes depicted on the Maya vase was onl
first link in a chain of iconogra
discovery of the Mesoamer
enema phenomenon. Suddenly,
eral previously enigmatic scenes
objects in classic Maya art had
meaning. A small clay figurine
a burial excavated in 1964 by M
can archeologists on the islan
Jaina, in the Gulf of Campeche,
picts a male in squatting position
hand reaching back to his rectum.
a long time Maya experts were
zled because the figure's pos
seemed to represent defecation.
would the Maya have interred su
scene as an offering to their dea

A small hole in the anus sugge
that a piece was missing—that s
small object previously inserted t
had either become lost during exc
tion or had been made of some pe
able material, long since deca
The discovery of the enema vase f
the Petén district seems to
solved the riddle. The little Maya
probably not defecating but was i
act of giving himself an enema.

The gods themselves were also
picted as indulging in the enema
ual. One Maya vase has the fig
of thirty-one underworld de
painted on it. A naturalistically
signed enema syringe dangles f
the paw of one of the principal
ures. Maya experts did not recog
the significance of the object
they had examined the enema vas
New York. As another exampl
polychrome bowl from Yucatán,
in the National Museum of Ant
pology in Mexico City, show
naked being with a pointed head
jecting himself with liquid.

The ritual importance of the int
cating enema is highlighted by the
volvement in the rite of one of
greatest underworld deities, an
lord associated with earth, water,
agricultural fertility. The Maya
have believed that this god—
identified by Mayanists only by
letter *N*, but very likely the s
deity as the ancient Yucatecan
Pauhatun—consisted of four pa
each part living in the underworld
supporting the four corners of
earth.

The quadripartite god is depi
on a fine vase in a private collec
in Chicago. Each of the four parts
a characteristically chapfallen f
Four young and fetching consorts
apparently preparing each of
god's representations for the en
rite. Enema pots with syringes on

ı front of two of the consorts. emale consorts may well represhe important Mother Goddess of laya, known as Ixchel, as sevigurine examples of the god *N* acing this goddess have been l.

e same association of the god *N*, les, and enemas is depicted on ıer pottery vase, with a consort n standing behind each god repıtation and untying his loincloth. n, the same enema pots are in of the consorts. So often are the ry forms and syringes encoun together that we must conclude hey were commonly used in the ıa rite.

ıe explicit depiction of enema riton Maya vases has led us to take v look at a hitherto puzzling type ay figurine from central Vera-, which also dates from the clasIaya period. Some archeologists interpreted these curious sculp- as representing human sacrifice. / are usually of males whose faexpressions suggest pleasure or ıtic trance, not death. Their legs aised, either draped over a high w or some other type of support se slightly spread, with the feet up in the air. The posture—and the enraptured look—suggest the intoxicating enema. The reclining position also conforms to the Anonymous Conqueror's description of the method of enema intoxication among the Huastecs.

The hallucinogenic, or intoxicating, enema is by no means dead in Middle America. While conducting linguistic research among the Huichols of western Mexico, ethnographer Tim Knab was shown a peyote enema apparatus used by an elderly woman shaman in the community of Santa Catarína. The bulb was made from a deer's bladder and the tube from the hollow femur of a small deer. The shaman prepared her peyote by grinding it to a fine pulp and diluting it with water. Instead of taking the mixture by mouth (Huichols normally eat the cactus whole or drink it as an infusion), she injected it rectally, experiencing its effects almost at once while avoiding its bitter, acrid taste and the nausea that even some experienced Indian *peyoteros* continue to feel as they chew the sacred plant.

The choice of deer bladder and deer bone as materials for the Huichol syringe is probably not a matter of practicality. Bird bone, light, slender and thin walled, would be more logical for the tube. But the Huichols hold the deer especially sacred, even to the point of deification, and they identify it so completely with the hallucinogenic cactus that peyote and deer become conceptually one and the same (*see* "An Indian Journey to Life's Source," *Natural History,* April 1973).

We do not know what materials the ancient Maya used for their syringes. To make the transition from Huichol to Maya requires an enormous jump in time and space. Fish bladders and bird bones, which are prominent in Maya art, might have served for the syringe, as might the milky sap of the latex, or rubber, tree. More important than the precise technology, however, is the discovery that, no less than the simpler folk of the South American tropical rain forests, the creators of the most flamboyant and intellectually advanced native civilization in the New World hit upon the enema as a technique of ecstacy—a practical means of ritually altering or transforming the ordinary state of consciousness. ☐

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Announcements

The recently opened **Discovery Room** offers children, from six to twelve years old, mysteries, puzzles, and the opportunity to delve into the wonders of natural science and anthropology. This is all done through the use of discovery kits. Each contains items for visitors to look at, feel, and then try to identify. One kit, "Reflections," allows children to dress up in Museum-owned costumes and jewelry to see how people around the world adorn themselves. Open only on weekends, the Discovery Room is located on the first floor of the Museum outside the entrance to the Hall of Ocean Life.

Treasures of Cyprus, a traveling exhibit of nearly 200 priceless art objects that recently arrived in this country, opened February 16 in Gallery 77 on the Museum's first floor. In its only New York appearance, the exhibit will remain at the Museum until April 3.

Spanning 8,000 years of the artistic and archeological history of Cyprus, the exhibit includes pottery, figurines, statues, vessels, and jewelry from Neolithic times to the nineteenth century. Culturally, the exhibit is a mirror of the island's varied past, which included successive periods of Phoenician, Assyrian, Egyptian, Persian, Greek, Roman, Venetian, Turkish, and British influence.

The exhibit, assembled under the auspices of the Cypriot government as a tribute to our country during its Bicentennial, is being circulated here by the Smithsonian Institution Traveling Exhibition Service.

The **Alvin Ailey Repertory Ensemble** will appear in the Museum Auditorium on March 6 at 2:00 P.M. Formed several years ago to give young dancers and choreographers an opportunity to develop both themselves and their art, the ensemble received wide acclaim for its 1974 television performance of "Ailey Celebrates Ellington." Most of the dancers are in their early twenties. The ensemble performs frequently in schools, prisons, hospitals, and occasionally with the American Ballet Theatre and the Alvin Ailey City Center Dance Theater, its parent group. Their repertory includes some of Ailey's best-known pieces, such as "Revelations" and "Night Creature." The performance at the Museum is free to those who have paid the daily admission donation.

Celestial Events

by Thomas D. Nicholson

Sun and Moon The sun moves into the constellation Pisces about March 12 and remains among its stars until late April. On March 20, it passes the vernal equinox at 12:43 P.M., EST, moving from south to north of the equatorial plane, which marks the end of winter and the beginning of spring in the Northern Hemisphere. The actual date on which our day and night are each twelve hours long, however, is March 17, because of the effect of atmospheric refraction and because we measure the beginning and end of the day by the sun's upper edge.

After bright evening moonlight in early March (full on the 5th), the moon is in the morning sky past mid-month (last-quarter on the 12th, new on the 19th). The slim evening crescent will appear on the 21st or 22nd, growing to first-quarter on the 27th. The moon will be full again on April 3, and it reaches last-quarter phase on April 10.

Stars and Planets The Star Map for March shows Jupiter and Saturn located prominently among our evening stars, where they have been all winter. But as spring approaches, they will shift slowly westward with each nightly appearance. Both stand out brilliantly, even in comparison with the bright winter stars.

The three evening planets are easy to distinguish. At dusk, Venus will be high and bright in the glow of the setting sun, Jupiter will be higher and to its left, and Saturn will be much farther left and quite high in the eastern sky. Venus sets first, about three hours after the sun on March 15, but much earlier by the end of the month. Jupiter sets several hours before midnight, and Saturn before dawn. Mercury and Mars are not well placed to be seen this month.

March 2–3: Saturn is near the moon both nights.

March 8: The moon is nearest the earth (at perigee).

March 14: Venus begins to move westward (retrograde) as its path takes it between the earth and the sun. This will cause it to leave the evening sky rapidly over the next few weeks.

March 16: Mercury is in superior conjunction, in line with, but beyond, the sun and enters the evening sky.

March 20: Vernal equinox, spring begins.

March 21: The crescent moon is near Venus tonight.

March 23–24: The bright object near the moon on both nights is Jupiter. The moon is farthest from the earth (at apogee) on the 24th.

March 30: The moon is near Saturn tonight; near the bright star Regulus (in Leo) on the 31st.

April 3–4: A partial lunar eclipse is visible from most of North America. At mid-eclipse, 11:18 P.M., EST, on the 3rd, about 20 percent of the moon's diameter is in the earth's shadow.

April 5: The moon is nearest the earth.

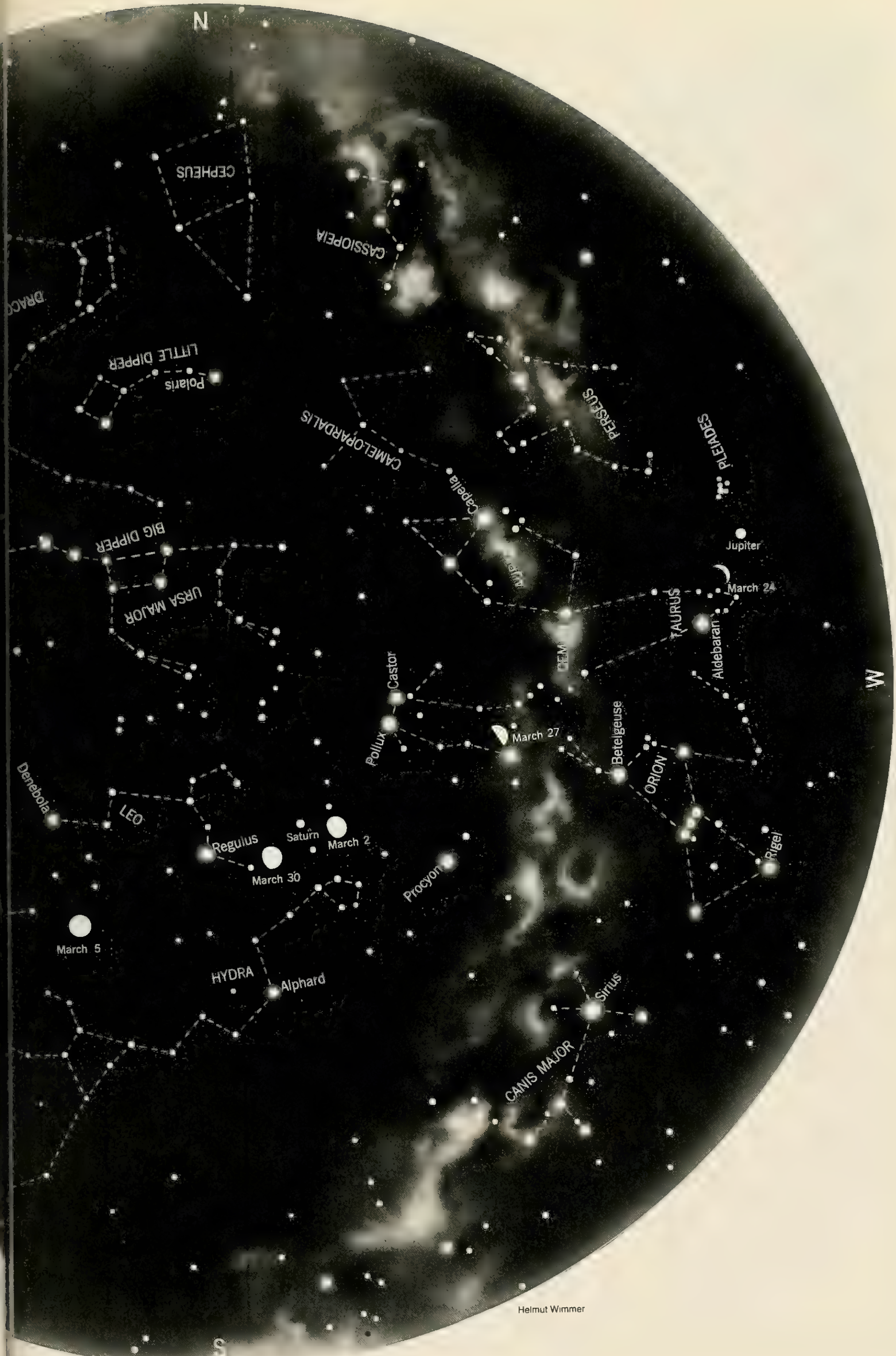
April 6: Venus passes between the earth and the sun (inferior conjunction) and becomes a morning star, visible low in the east at dawn in about two weeks.

April 10: Mercury is at its greatest distance to the east (left) of the sun, placing it favorably as an evening star. The planet is in good position for a week preceding and following this day to be seen low in the west after sundown.

April 11: Saturn ends its retrograde motion and begins to move eastward. It has been moving away from Regulus, in Leo, but it now moves left toward the star.

Vega
HERCULES
CORONA BOREALIS
March 8

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on March 1; 10:25 P.M. on March 15; 9:20 P.M. on March 31; and 8:20 P.M on April 15; but it can be used for an hour before and after those times.


N
CEPHEUS
CASSIOPEIA
DRAC
LITTLE DIPPER
Polaris
CAMELOPARDALIS
PERSEUS
PLEIADES
Capella
BIG DIPPER
Jupiter
March 24
URSA MAJOR
TAURUS
Aldebaran
Castor
W
Pollux
March 27
Betelgeuse
ORION
Denebola
LEO
Regulus
Saturn
March 2
Rigel
March 30
Procyon
March 5
HYDRA
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Whooping Cranes (p. 22)

Faith McNulty's *The Whooping Crane* (New York: E.P. Dutton, 1966) and L.H. Walkinshaw's *Cranes of the World* (New York: Winchester Press, 1972) cover what little is known of the biology and habitat of this endangered species. David R. Zimmerman's chapter on whoopers in his book *To Save a Bird in Peril* (New York: Coward, McCann & Geoghegan, 1975, $9.95) and his article for *Natural History*, "Captive Breeding: Boon or Boondoggle" (December 1974, pp. 6–19), describe the initial, and largely unsuccessful, attempts of the U.S. Fish and Wildlife Service to save these cranes from extinction. Zimmerman's writings present a critical contrast to the currently more fruitful cross-fostering efforts of United States and Canadian biologists. Richard S. Miller's "The Programmed Extinction of the Sandhill Crane" (*Natural History*, February 1974, pp. 62–69) puts in perspective the status of the foster-parent species that has been pressed into the service of the whooping crane. The June 1976 issue of *Nature Canada* contains many photographs and two informative articles on whooping cranes: Ernie Kuyt's "Whooping Cranes: The Long Road Back" (pp. 2–9), a well-illustrated, knowledgeable description of their breeding habitat and reproduction in the wild, as well as a detailed account of the Canadian contribution to the various efforts to save the whooper, and R. Dalton Muir's "Whooping Crane Summer: Filming the Great White Cranes" (pp. 25–30), a narrative of a project aimed at documenting the behavior of adult and newly hatched whoopers on their breeding grounds.

Howling Monkeys (p. 34)

Martin Moynihan's *The New World Primates* (Princeton: Princeton University Press, 1976), an up-to-date account of primate biology, ecology, and behavior, is devoted entirely to monkeys of the Americas. Modern primatologists still use many of the same techniques of, and compare their results with, the classic research of Clarence Ray Carpenter: "A Field Study of the Behavior and Social Relations of Howling Monkeys" (*Comparative Psychology Monographs*, 1934, vol. 10, pp. 1–168). Details of Kenneth E. Glander's own work are given in "Habitat Description and Resource Utilization: A Preliminary Report on Mantled Howling Monkey Ecology" (pp. 37–57), his contribution to *Socioecology and Psychology of Primates*, edited by Russell H. Tuttle (The Hague: Mouton, 1975). *Coevolution of Animals and Plants*, edited
by L.E. Gilbert and P.H. Raven (Au
University of Texas Press, 1975),
tains Paul Feeny's article on how
toxins function as defenses against
eaters: "Biochemical Coevolution
tween Plants and Their Insect H
vores" (pp. 3–19). Biochemist T
Robinson's "Metabolism and Fun
of Alkaloids in Plants" (*Science,*
vol. 184, pp. 430–35) also discusses
poisons protect plants from being ov
ploited. One of the few papers avai
on detoxification systems of the mam
ian digestive tract, William Freelan
Daniel H. Janzen's "Strategies in H
vory by Mammals: The Role of
Secondary Compounds" (*American*
uralist, 1974, vol. 108, pp. 269
gives information on several primat

Korean Dance (p. 42)

Traditional Performing Arts of K
published by the Korean Commissio
UNESCO (Seoul, 1975), provid
broad perspective on that country's
music, dance, and drama; see, fo
ample, Yi Tu-Hyon's "Mask D
Dramas" (pp. 35–80) for details of
and characters and dozens of color
tographs. Anneliese Stucki's "S
Aspects of Korean Masks and M
Dance Drama" (*Asia & Pacific Q*
terly of Cultural and Social Af
1975, vol. 7, no. 2, pp. 12–17) is an
useful source of background informa
"Korean Folk Music and Dance,"
Alan C. Heyman (pp. 90–110),
"Korean Folk Play," by Lee Du-H
(pp. 112–29), are two of the six es
in *Folk Culture in Korea,* edited by
Shin-Yong (Seoul: International Cul
Foundation, 1974). This collection
attempt to explore the patterns and m
of Korean culture, the balance and
mony between tradition and reality
they contribute to the Korean nati
identity. Heyman's Western appr
and deep understanding of the eso
beauty of Eastern folk cultures are
found in his *Dances of the Three-T*
sand-League Land (New York:
demic Press/Johnson Reprint, 1
$5.50), an introduction to Korean t
tional dance. Write to The Perfor
Arts Program of the Asia Society,
East 58th Street, New York, N.Y. 10
for their *Monographs on Music, Dr*
and Theater in Asia (1976, vol. 3, $4
in an attractive batik folder), three m
graphs on Korean dance, Japanese s
martial arts, and Indian dance theate

Mars (p. 48)

Radioastronomer Ronald N. Br

The Galactic Club: Intelligent Life ter Space (San Francisco: W.H. ıan, 1975, $3.95) is a popular, lative discussion of the evidence for sewhere in the universe, including bearing on what other living crea- might look like. Robert Jastrow's *Giants and White Dwarfs: Man's nt from the Stars* (rev. ed. New New American Library, 1971,) provides a general background on gical and astronomical evolution in smos. Rick Gore's "Sifting for Life Sands of Mars" (*National Geo- ic*, January 1977, pp. 8–31) de- s the key *Viking* lander experiments igating the question of life on the lanet. Several recent issues of *ce*, beginning with August 27, 1976 193, pp. 759–815), are totally de- to presentations of some of the data ack by *Viking I;* data from *Viking* likewise presented, beginning with ecember 17, 1976, issue (vol. 194, 277–1353). Gilbert V. Levin and ia Ann Straat's "Viking Labeled se Biology Experiment: Interim Re- " (pp. 1322–29), for example, sum- es one life detection experiment.

Diomede Island (p. 54)
d Bruemmer's *The Arctic* (New Quadrangle, 1974) offers an over- rspective on the peoples and places far north, while "The Northern- People" (*Natural History*, Febru- 74, pp. 24–33), a graphically illus- description of the lives of Green- s Eskimo, is an insightful contrast to resent account of the Diomede Is- rs. *Alaska*, by Bern Keating (Wash- n: National Geographic Society,), contains a section dealing specifi- with the Diomede Islands. William unt's *Arctic Passage* (New York: es Scribner's Sons, 1975, $12.95) nts the history of the Bering Sea re- north of the Aleutians, illustrated early photographs of ships and crews ng and trading there. *The Bering Bridge*, edited by David M. Hop- (Stanford: Stanford University , 1967), is a scholarly, wide-ranging ction of studies of Beringia. Edward Nelson's classic (1899) monograph e Smithsonian Institution's Bureau merican Ethnology, *The Eskimo t Bering Strait*, has been recently nted (New York: Academic /Johnson Reprint, 1971).

tids (p. 66)
gh B. Cott's *Adaptive Coloration in als* (New York: Halsted Press, 1959) and Wolfgang Wickler's *Mimicry in Plants and Animals* (New York: McGraw-Hill Books, 1968, $2.45) provide, respectively, the classic biological and modern ethological interpretations of animal camouflage. Two of Malcolm Edmund's nicely illustrated field studies have been published recently in the *Zoological Journal of the Linnean Society:* "Defensive Behaviour in Ghanian Praying Mantids" (1972, vol. 51, pp. 1–32) and "The Defensive Behaviour of Ghanian Praying Mantids with a Discussion of Territoriality" (1976, vol. 58, pp. 1–37). Jocelyn Crane's "A Comparative Study of Innate Defensive Behavior in Trinidad Mantids" (*Zoologica*, 1952, vol. 37, pp. 259–93) is a technical account of some mantids' reactions to predation. General background information on mantid behavior is found in E. Jaediker Norsgaard's "Connubial Cannibalism" (*Natural History*, November 1975, pp. 58–63).

Maya Drugs and Enemas (p. 88)
Peter Furst's *Hallucinogens and Culture* (Corte Madera: Chandler & Sharp Publishers, 1976, $4.95) provides a historical overview of the use of hallucinogens in a variety of cultural settings, including those of the Indians of Middle and South America. Furst has also edited a popular collection of papers on native drugs and their use, *Flesh of the Gods* (New York: Praeger Publishers, 1972, $4.95); and his latest work, "High States in Culture-Historical Perspective," will appear this spring in *Alternate States of Consciousness*, edited by psychiatrist Norman E. Zinberg (New York: Free Press). For background information on major themes in Maya cosmology and history see these works: J. Eric Thompson's *Maya History and Religion* (Norman: University of Oklahoma Press, 1970, $7.95), Elizabeth P. Benson's *The Maya World* (New York: Apollo Editions, 1972, $2.95), and Michael D. Coe's *The Maya* (New York: Praeger Publishers, 1966, $3.95). Coe's *Classic Maya Pottery at Dumbarton Oaks* (Washington: Dumbarton Oaks, 1975, $20) provides excellent photographs and polychrome rollout drawings of the techniques and subjects of Maya vase painting. *Death and the Afterlife in Pre-Columbian America*, edited by Elizabeth P. Benson (Washington: Dumbarton Oaks, 1975, $10), presents a number of interpretations of Maya funerary practices and conceptions of death and the underworld.

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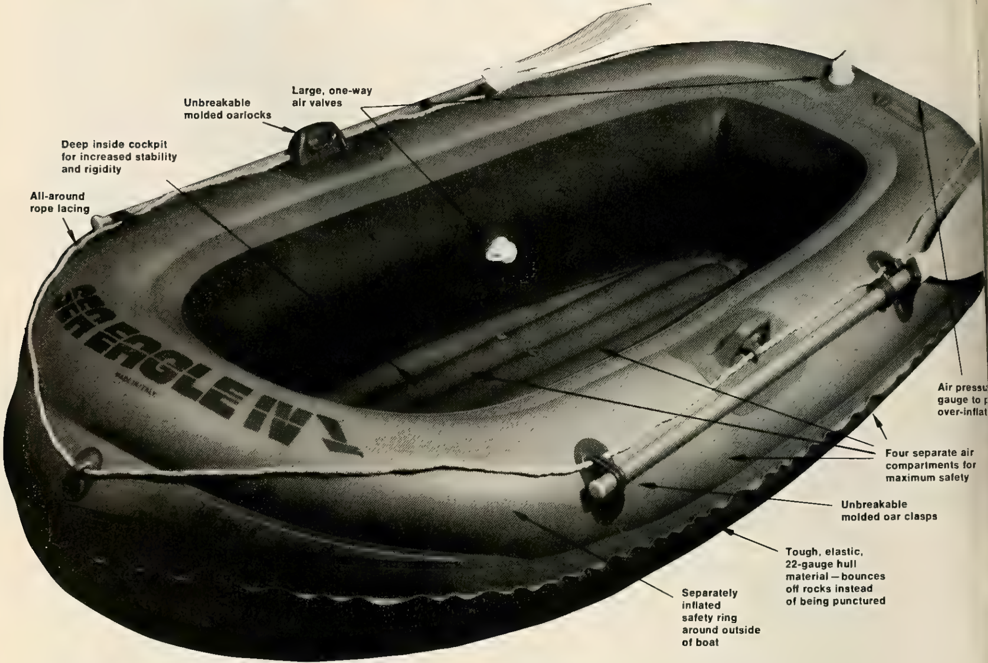
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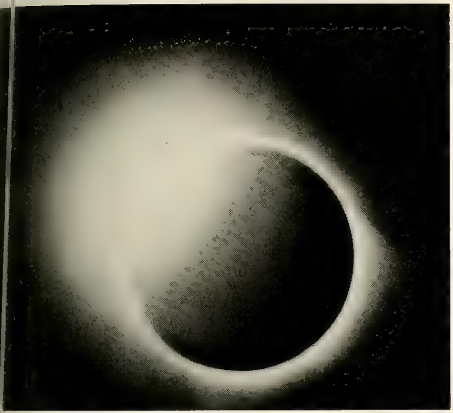

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April 1977

The American Museum of Natural History
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Cover *Iceland, which straddles the Mid-Atlantic Ridge, is one of the world's most prominent "hot spots." Its villages thus run the risk of being buried under volcanic ash and showered with molten lava. Photograph by Pete Turner. Story on page 36.*

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Authors

The article on tobacco marks **Erik Eckholm**'s second appearance in these pages. His first was "The Firewood Crisis," in the October 1975 issue. A somewhat revised version of his current article will be part of a book for which the research was sponsored by the U.N. Environment Program. Eckholm writes on environmental subjects for the Worldwatch Institute, a Washington-based, nonprofit research organization concerned with global problems. He has investigated the health situation in Egypt and Southeast Asia and traveled widely in Africa, Asia, Europe, and the Soviet Union. A graduate of Occidental College in Los Angeles, Eckholm got a master's degree in 1974 from the Johns Hopkins University School of Advanced International Studies. Although he eschews cigarettes, he does admit to puffing occasionally on a pipe.

"I began looking at the ocean floor around Iceland in 1971," writes marine geophysicist **Peter R. Vogt**. During the last ten years he has crisscrossed the oceans many times on research vessels and in specially equipped planes, gathering information on hot spots, continental drift, and plate tectonics. In 1975, he was an exchange scientist for two months aboard a Russian research ship in the South Atlantic and served as cochief scientist on Log 43 of the *Glomar Challenger* in the North Atlantic. Vogt is now with the Naval Research Laboratory in Washington, D.C. His hobbies while on dry land include pottery, woodcarving, candlemaking, and collecting and cooking wild fruits and vegetables. He also collects cartoons on his speciality of hot spots in the belief that "scientists should learn to stand back and laugh."

Michael Harner is professe
anthropology and former chairm
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for Social Research in New
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Amazon region and in recent
has devoted himself to expla
human, social, and cultural evol
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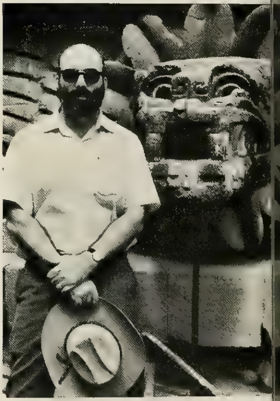
falls and *Hallucinogens and Sha*
ism.



Because the threatened Illinois
turtle presented an interesting e
tionary problem and its natural
tory was virtually unknown,
Cooper spent two summers i
sloughs and on the dunes of M
tine Island, Iowa, studying this
subspecies. The work became
basis of his master's degree res
at Drake University. He has just
pleted a contract study for the U
States Fish-Pesticide Research L
ratory (U.S. Fish and Wildlife
ice) in Columbia, Missouri, whi
volved a test of the usefulness
compartmentalized food chai
evaluating the hazards presente
aquatic contaminants. In his
time, Cooper backpacks and
cross-country skiing.

Any ordinary camera could have taken this photograph.

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A few years ago, **Tor Eige**
happened to meet a cousin of
Buñuel, the Spanish filmmaker.
cousin mentioned that Buñuel c
from the small town of Cala
which annually celebrates Good
day with a long and dramatic dr
ming ceremony. Eigeland, of No
gian birth, now lives in Spain and
been a free-lance photographer
writer since his student days in M
ico City. He has carried out m
photographic assignments in the M
dle East and is at present doing
search on the Arabian Gulf she
dom of Sharjah. His other project
clude studying Islam and p
tographing the rebuilding of Leba

Howard Topoff is an associate professor of psychology at Hunter College of the City University of New York (CUNY) and a research associate in animal behavior at The American Museum of Natural History. His field work with antlions was conducted in conjunction with animal behavior classes at the Museum's Southwestern Research Station in Arizona. The doctoral students and faculty participating in this course are part of a joint CUNY-Museum Ph.D. program in animal behavior. Topoff's present research is on the development and evolution of insect behavior, especially that of ants. He is the author of "Ants on the March," which appeared on the December 1975 issue of *Natural History*.

Living on an old racing sloo
Newport Harbor, California, **Ph**
Dustan is never far from the wa
When he is not on it, he is ofte
it, having prowled around coral r
from the Red Sea to the Caribb
He has been fascinated by their c
plexity ever since his undergrad
days when he took a biology field
to the Bahamas. In 1974, wher
directed a Smithsonian Institu
project to assess man-induced d
age to the Florida reefs, a sail
blundered onto a reef and he g
firsthand look at its fragility. Dus
a lecturer in ecology at the Univer
of California at Irvine, is research
the dynamics of coral reef pop
tions and plans to concentrate his
ture studies on the photosynth
capacities of certain algae specie

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Dr. Hans Selye:

ON STRESS WITHOUT DISTRESS

The secret is *adaptability* . . . your mind can make or break you!

PUBLISHER'S NOTE: *Hans Selye, C.C., M.D., Ph.D., D.Sc., F.R.S. (C) is the world-famous endocrinologist whose concept of stress has been called at the World Congress of Medical Psychology: "breathtaking in its scope; it has permeated medical thinking and influenced medical research in every land, probably more rapidly and more intensely than any other theory of disease ever proposed." As a long-time member of our Editorial Board we have asked Dr. Selye to outline for you his concept, detailed in his many scientific papers and books, the latest of which "Stress Without Distress"(*) is stated in clear, non-technical language we believe especially helpful to executives.* —Richard Stanton

Everybody knows what stress is and nobody knows what it is. The word stress, like success, failure, or happiness, means different things to different people and, except for a few specialized scientists, no one has really tried to define it although it has become part of our daily vocabulary. Is it effort, fatigue, pain, fear, the need for concentration, the humiliation of censure, loss of blood, or even an unexpected success that requires complete reformulation of one's life? The answer is yes and no. That is what makes the definition of stress so difficult. Every one of these conditions can produce stress, and yet none of them can be singled out as being "it" since the word applies equally to all others as well.

Yet, how are we to cope with the stress of life if we cannot even define it? The executive who is under constant pressure from his customers and employees alike, the air traffic controller who knows that a moment of distraction may mean death to hundreds of people, the athlete who desperately wants to win a race, and the husband who helplessly watches his wife slowly and painfully die of cancer — all suffer from stress. The problems they face are totally different, but medical research has shown that in many respects their bodies respond in a stereotyped manner with

---

(*) **Stress Without Distress** . . . *How to achieve a rewarding life style in harmony with the laws of nature, by using stress as a positive force for personal achievement and happiness.* J. B. Lippincott Co., Philadelphia and New York. Copyright 1974 by Hans Selye, M.D.

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The 120-year Bamboo Clock

"Natural history, to a large extent, is a tale of different adaptations to avoid predation."

Nature usually manages to outdo even the most fanciful of human legends. Sleeping Beauty waited a hundred years for her prince. Bruno Bettelheim argues that her pricked finger represents the first bleeding of menstruation; her long sleep, the adolescent years before full maturity. Since the original Sleeping Beauty was inseminated by a king, rather than merely kissed by a prince, we may interpret her awakening as the beginning of sexual fulfillment.

A bamboo that bears the unpronounceable name *Phyllostachys bambusoides* flowered in China in the year 919. Since then, with unerring regularity, it has continued to flower and set seed roughly every 120 years. *P. bambusoides* follows this cycle wherever it lives. In the late 1960s, Japanese stocks of the bamboo (transplanted from China centuries before) set seed simultaneously in Japan, England, Alabama, and Russia. The analogy to Sleeping Beauty is not farfetched, for sexual reproduction follows more than a century of celibacy in these bamboos. But *P. bambusoides* departs from the brothers Grimm in two important ways. The plants are not inactive during their 120-year vigil—they propagate asexually by producing new shoots from underground rhizomes. Also, they do not live happily ever after, for they die after setting seed.

Ecologist Daniel H. Janzen of the University of Pennsylvania recounts the curious tale of *Phyllostachys* in a recent article in the *Annual Review of Ecology and Systematics* (1976). Most species of bamboo have shorter periods of vegetative growth between flowerings, but synchroneity of seeding is the rule, and most species wait more than 15 years before flowering (some may wait more than 150 years, but historical records are too sparse to permit firm conclusions).

These flowerings must be set by internal, genetic clocks, not imposed from without by some environmental clue. Our best evidence for this assertion is the unerring regularity of repetition. We do not know any environmental factor that cycles so predictably to yield the variety of clocks followed by more than a hundred species of bamboo. Secondly, plants of the same species flower simultaneously, even when transplanted half a world away from their native habitat. Finally, plants of the same species flower together, even if they have grown in very different environments. Janzen recounts the tale of a Burmese bamboo only half a foot high that had been burned down repeatedly by jungle fires, but flowered at the same time as its unmolested companions standing forty feet tall.

How can a bamboo count the passing years? Janzen argues that the plant cannot be measuring stored food reserves because starved dwarf plants flower at the same time as healthy giants. He speculates that the calendar "must be the annual or daily accumulation or degradation of a temperature-insensitive photosensitive chemical." He finds no basis for guessing whether the cycles of light are diurnal (day–night) or yearly (seasonal). As circumstantial evidence for implicating light as a clock, Janzen points out that no accurately cycling bamboo grows near the equator,
where variations in both days an
sons are minimal.

Most of us are better acqua
with another example of str
periodicity—the periodical cicad
17-year "locust." (Cicadas are
locusts at all, but large-bodied m
bers of the order Homoptera, a g
of predominantly small insects
cluding aphids and their relati
The story of periodical cicada
even more amazing than most pe
realize: for 17 years the nymphs
underground, sucking juices from
roots of forest trees all over the
ern half of the United States (ex
for our southern states, where a s
lar group of species emerges ever
years). Then within just a few we
millions of nymphs emerge from
ground, become adults, mate,
their eggs, and die. (The best
counts, from an evolutionary st
point, will be found in a series o
ticles by M. Lloyd and H. S. Dy
published in the journals *Evolu*
1966, and *Ecological Monogra*
1974.)

The most remarkable fact is
not one, but three separate speci
periodical cicadas follow prec
the same schedule, emerging toge
in strict synchrony. Different
may be out of phase—popula
around Chicago do not emerge in
same year as forms from New
land. But each "brood" follow
unvarying 17-year cycle (13 yea
the south)—in the same place
three species always emerge
gether. Janzen recognizes that
cadas and bamboos, despite their
logical and geographic distance,
resent the same evolutionary p
lem. Recent studies, he writes,
veal no conspicuous qualitative
ference between these insects
bamboo . . . except perhaps in

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way they physiologically c
years."

As evolutionists, we seek ans
to the question, Why? Why, in pa
ular, did such striking synchro
evolve, and why the long perio
tween episodes of sexual repro
tion? As I argued in discussing
matricidal habits of certain flies
cember 1976), the theory of na
selection receives its strongest
port when we devise satisfactory
planations for phenomena that s
us intuitively as bizarre or sense

In this case, we are confronted
a problem beyond the apparent p
liarity of such wastefulness (for
few seeds can sprout upon such
rated ground). The synchroneit
flowering or emergence seems t
flect an ordering and harmony op
ing upon the species as a whole
upon its individual members.
Darwinian theory advocates
higher principle beyond indivi
pursuing their own self-interes
promoting their own genes in fu
generations. What advantage
the synchroneity of sex provide
the individual cicada or bam
plant?

The problem is similar to that f
by Adam Smith when he advoc
an unbridled policy of laissez fai
the surest path to a harmonious e
omy. The ideal economy, Smit
gued, might appear orderly and
balanced, but it would emerge "n
rally" from the interplay of ind
uals following no higher prin
than the pursuit of their own bes
terests. The apparent direc
toward a higher harmony, S
argues in his famous metaphor,
reflects the operation of an "invi
hand."

> As every individual . . . by directing
> industry in such a manner as its pro
> may be of greatest value, intends onl
> own gain, he is in this as in many
> cases led by an invisible hand to pro
> an end which was no part of his inten
> . . . By pursuing his own interest he
> quently promotes that of society mor
> fectively than when he really inten
> promote it.

Since Darwin, via Malth
grafted Adam Smith upon natur
establish his theory of natural se
tion, we must seek an explanation
apparent harmony in the advan
that it confers upon individu
What, then, does an individual ci
or bamboo gain by indulging in
so rarely and, then, at the same
as all its compatriots?

From the rim of the Black Canyon of the Gunnison, an empty tin can will
l 2,425 feet.

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places as they are for people. Where
d has touched his hand, let no man
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w we help landowners

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In order to appreciate the most l
ly explanation, we must recog
that human biology often provid
poor model for the struggles of o
organisms. Humans are slowly gr
ing animals: we invest a great de
energy in raising very few, late-
turing offspring. Our populations
not controlled by the wholesale d
of nearly all juvenile members.
many organisms follow a diffe
strategy in the "struggle for e
ence": they produce vast numbe
seeds or eggs so that a few will
vive the rigors of early life. T
organisms are often controlled
their predators, and their evolut
ary defense must be a strategy
minimizes the chance of being ea
Cicadas and bamboo seeds seem t
particularly tasty to a wide variet
organisms.

Natural history, to a large ext
is a tale of different adaptation
avoid predation. Some individ
hide, others taste bad, others g
spines or thick shells, still ot
evolve to look conspicuously li
noxious relative—the list of ada
tions is nearly endless, a stun
tribute to nature's variety. Bam
seeds and cicadas follow an unc
mon strategy: they are eminently
conspicuously available, but so ra
and in such great numbers that pr
tors cannot consume the en
bounty. Among evolutionary bi
gists, this defense goes by the n
of "predator satiation."

An effective strategy of pred
satiation involves two adaptati
First, the synchrony of emergenc
reproduction must be very pre
thus assuring that the market is t
flooded, but only for a short t
Second, this flooding cannot o
very often lest predators simply
just their own life cycles to pre
able times of superfluity. If baml
flowered every year, seed ea
would track the cycle and pre
their own abundant young with
annual bounty. But if the period
tween episodes of flowering fa
ceeds the life-span of any pred
then the cycle cannot be tracked
cept by one peculiar primate
records its own history). The ad
tage of synchroneity to indivi
bamboos and cicadas is clear eno
anyone out of step is quickly gob
up (cicada "stragglers" do occas
ally emerge in off years, but
never gain a foothold).

The hypothesis of predator s
tion, although unproved, meets

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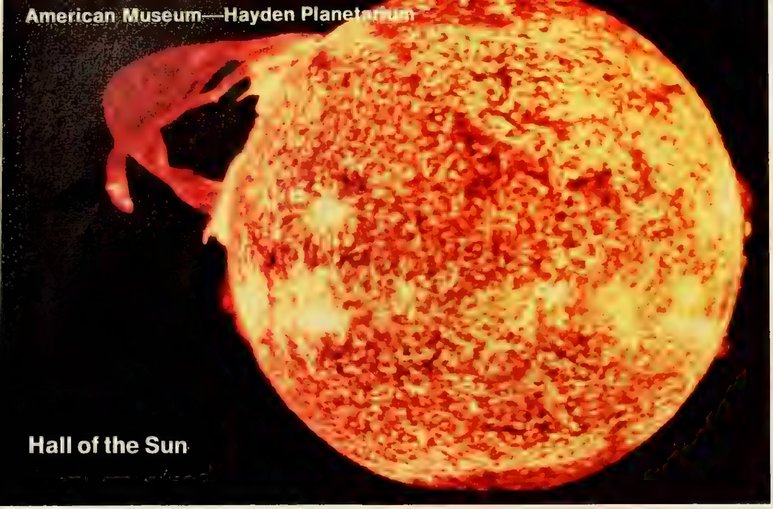

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primary criterion of a successful planation. It coordinates a suite of servations that would otherwise main unconnected and, in this ca downright peculiar. We know, example, that bamboo seeds are ished by a wide variety of anim including many vertebrates with l life-spans; the rarity of flower cycles shorter than fifteen or twe years makes sense in this context. also know that the synchronous ting of seed can inundate an affec area. Janzen records a mat of se six inches deep below the pare plant in one case. Two species Malagasy bamboos produced 50 k grams (110 pounds) of seed per h tare (2.47 acres) over a large are 100,000 hectares during a m flowering.

The synchrony of three spec among cicadas is particularly imp sive—especially since years of em gence vary from place to place, w all three species invariably emerge gether in any one area. But I am m impressed by the timing of the cy themselves. Why do we have 13- 17-year cicadas, but no cycles of 14, 15, 16, or 18 years? The numb 13 and 17 share a common prope They are large enough to exceed life cycle of any predator, but they also prime numbers (divisible by integer smaller than themselv Many potential predators have 2 5-year life cycles. These cycles not reflect the availability of peri cal cicadas (for they peak too o in years of nonemergence), but cadas might be eagerly harve when the cycles coincide. Consid predator with a cycle of five year cicadas emerged every fifteen ye each bloom would be hit by the pre tor. By cycling at a large prime n ber, cicadas minimize the numbe coincidences (every 5 × 17 years 85 years in this case). Cycles of and 17 years cannot be tracked by smaller number.

Existence is, as Darwin state struggle for most creatures. weapons of survival need not claws or teeth; patterns of reprod tion may also serve. Occasio superfluity is one pathway to succ It is sometimes advantageous to all your eggs in one basket, bu sure to make enough of them— don't do it too often.

Stephen Jay Gould teaches biol geology, and the history of scienc Harvard University.

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Celestial Events

by Thomas D. Nicholson

Sun and Moon The sun is moving eastward through the stars of Pisces until April 19, and then moves into Aries, where it remains until mid-May. This motion takes it progressively farther north of the equatorial plane, bringing longer days and shorter nights to the Northern Hemisphere. The moon is full on April 3, then moves into the morning sky to last-quarter on the 10th and new on the 18th. The early evening crescent moon should show up about April 20 or 21, waxing while it remains later in the evening sky through first-quarter on April 26 and full again on May 3. Last-quarter moon occurs again on May 9.

The sun and the moon will combine to produce four eclipses in 1977. The first, on April 3–4, is a partial lunar eclipse visible in the United States and Canada except in the extreme northwest. Later in the month (April 18), a solar eclipse will occur in the Southern Hemisphere, visible as a partial eclipse in a wide area. A penumbral lunar eclipse on September 26–27 and a solar eclipse on October 12 will also be seen from North America.

Stars and Planets Of our three beautiful evening stars this past winter, only one remains on the evening Star Map for April. Venus is gone from the evening sky, becoming a morning star early in the month and reappearing low in the east at dawn by late April. Jupiter is still in the evening sky, but too low in the west to be shown on the map. It becomes visible at dusk in the southwest, in Taurus, just west of the v-shaped Hyades cluster, and then sets within a few hours. Saturn is still on our map, high in the south as darkness begins. It is in Cancer, about midway between the twin stars (Pollux and Castor) of Gemini and Regulus in Leo. Saturn sets soon after midnight.

Mercury is in favorable position as an evening star in the first half of April, low in the west after sunset. Venus and Mars are morning stars but not well placed for viewing.

April 3–4: Partial lunar eclipse in North America.

April 5: The moon is nearest the earth (perigee).

April 6: Venus, in inferior conjunction with the sun, becomes a morning star.

April 10: Mercury is at greatest easterly elongation.

April 11: Saturn resumes direct (easterly) motion.

April 18: Solar eclipse in the Southern Hemisphere, annular across southern Africa.

April 19: Mercury is in conjunction with the moon and begins its retrograde (westerly) motion.

April 20–21: The bright object near the moon is Jupiter.

April 22: Lyrid meteors (15 per hour) reach maximum.

April 24: Daylight time begins. Venus resumes direct motion.

April 30: Mercury, in inferior conjunction with the sun, becomes a morning star.

May 3–4: Perigee moon occurs 16 hours after full moon, producing tides that are stronger than usual.

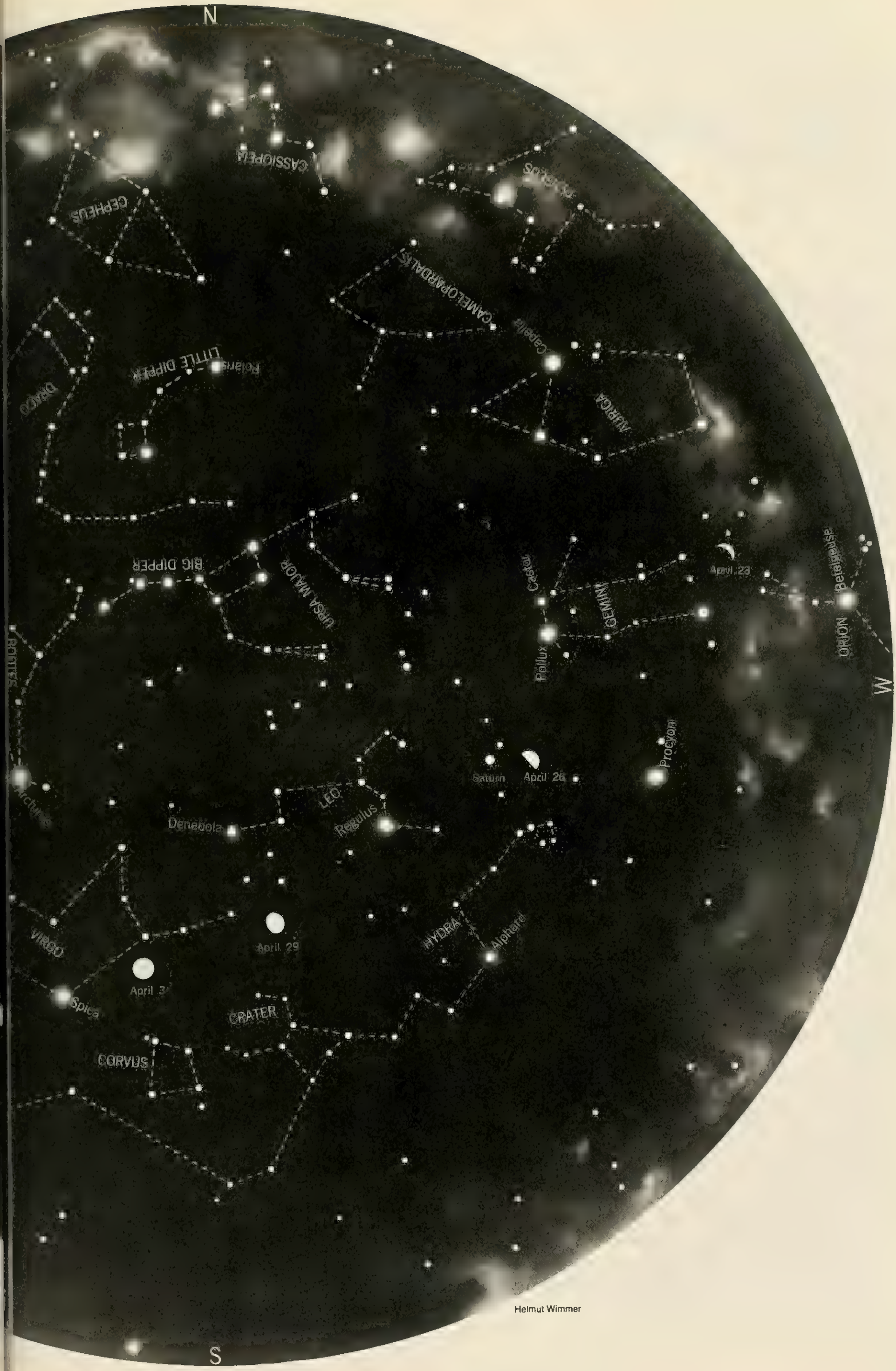
May 5: The Eta Aquarid meteor shower reaches maximum. You may see up to 20 meteors per hour in the after-midnight sky.

May 11: Venus is at greatest brilliancy in the morning sky.

May 13–14: Venus and Mars are in conjunction on the 13th, each is in conjunction with the moon on the 14th, and the moon passes in front of Venus (an occultation) over parts of North America.

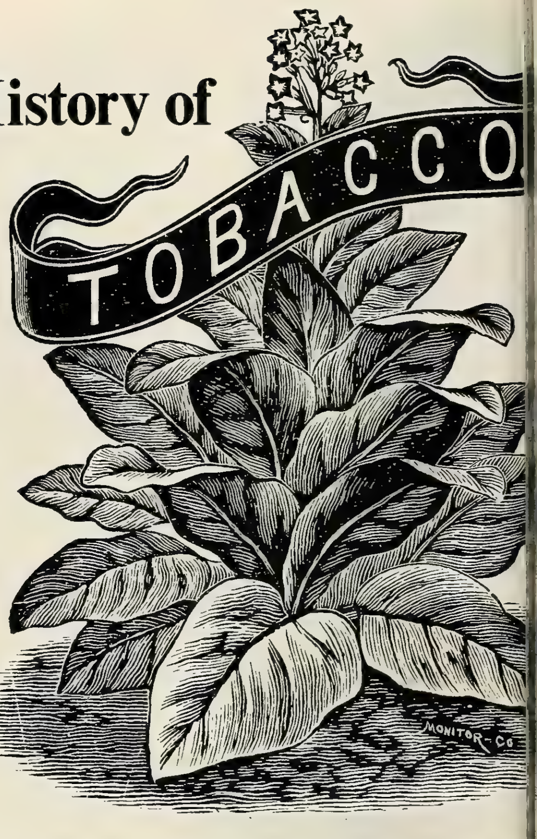
★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:15 P.M. on April 1; 10:20 P.M. on April 15; 9:25 P.M. on April 30; and 8:25 P.M. on May 15; but it can also be used for an hour before and after those times.

Aquila
LYRA
Vega
HERCULES
Rasalhague
E
OPHIUCHUS
April
SCORPIUS


N
CASSIOPEIA
PERSEUS
CEPHEUS
CAMELOPARDALIS
Capella
LITTLE DIPPER
Polaris
DRACO
AURIGA
BIG DIPPER
URSA MAJOR
Castor
GEMINI
April 23
Betelgeuse
ORION
Pollux
BOOTES
W
Procyon
Saturn
April 26
LEO
Regulus
Denebola
Arcturus
VIRGO
HYDRA
Alphard
April 29
April 3
Spica
CRATER
CORVUS
S

Helmut Wimmer

The Unnatural History of



by Erik Eckholm

Cigarettes are both a health hazard and a source of revenue. Governments are thus ambivalent in their efforts to discourage smoking

When accosting a tourist, a street waif in Cairo is as apt to beg for a cigarette as for coins. In the People's Republic of China, a country renowned for its health-care campaigns, national leaders chain-smoke as they preside over the world's largest tobacco industry. More than a decade after the United States government declared smoking to be a health hazard, four out of ten American males and three out of ten American females smoke—and the federal Department of Agriculture spends $50 million a year supporting the tobacco industry.

How is it that such a harmful product has become so firmly entrenched in daily life the world over? That tobacco occupies good farmland in India while peasants starve nearby? That the cigarette merchants are allowed to use Madison Avenue's wiliest marketing techniques to cajole youngsters into a lifetime of smoking? Like a dime novel, the tale of the three-cent cigarette is one of intrigue, corporate power, and governmental hypocrisy; of human pleasure, addiction, and premature death.

"This vice will always be condemned and always clung to," wrote the perceptive Italian physician Bernardino Ramazzini in 1713 of tobacco use. Trying to figure out why Italian tobacco workers prized their jobs despite the severe head and stomach ailments tobacco dust inflicted upon them, Ramazzini, considered by many to be the father of industrial medicine, made another observation of equal present-day weight when he noted that "the sweet smell of gain makes the smell of tobacco less perceptible and less offensive to those workers."

Although the medical case against smoking has been conclusively established only within the last quarter century, tobacco has had powerful opponents, as well as powerful champions, almost from the moment sixteenth-century explorers gave Europe its first whiff. Yet from the beginning, the lure of profits, social fashions, and the association of tobacco with relaxation have all helped propagate its use. Today, despite the medical community's consensus and exhortations, the smoking habit continues to spread throughout most of the world. Indeed, many countries are just now entering the era of tobacco-induced disease and death.

Native Americans were the first tobacco smokers, but their European conquerors turned smoking and other
forms of tobacco use into glo
habits. Sir Walter Raleigh, the col
ful favorite of Queen Elizabet
court, popularized smoking in E
land during the late sixteenth centu
The practice caught on fast and e
orders for tobacco were filled
Spain's New World colonies. U
Elizabeth's death in 1603, howe
British rule fell to James I, who fo
Raleigh's smoking habit as objecti
able as he found the courtier's p
tics. (James eventually beheaded
leigh for political reasons, but
nineteenth-century writer clai
that smokers could consider Rale
"the first martyr in their cause.")

James declared that tobacco
was unhealthy, unholy, and a
gether unbefitting a civilized socie
He concluded his famous *Coun*
Blaste to Tobacco, published
1604, by characterizing smoking

> a custom lothsome to the eye, hateful

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> Nose, harmefull to the braine, danger- to the Lungs, and in the blacke stink- ume thereof, neerest resembling the ible Stigian smoke of the pit that is omelesse.

ven as James fumed, other people e making extravagant claims ut the salubrious powers of to- co smoke. Some doctors pre- bed smoking as an antidote to ls and fevers; some even believed inhaled smoke might ward off the gue. During the plague year of 3, all the schoolboys at Eton ere obliged to smoak in the school y morning," reported a certain n Rogers, who also said that he er received a harsher whipping the one he suffered one morning unishment for not smoking.

espite the antismoking campaign ducted by James and several of his lish successors and the unbudg- opposition of Emperor Jahangir in a, tobacco use quickly spread ughout Europe and then, through tentacles of the colonial system, he world. As one pipe lover ex- d in 1895 over tobacco's spread, ince and peasant alike yielded to mild but irresistible sway." In teenth-century Italy, Ramazzini orted, tobacco was smoked or in- ed by "women as well as men and n children," and its purchase was ckoned among the daily expenses family."

he spreading demand and, hence, wing commercial market for to- co in sixteenth- and seven- th-century Europe spurred the rgence of a lucrative industry. tish colonists settled in Virginia ecting to cash in on the New rld's precious metals, lumber, , and fish; instead, they learned only tobacco exports could keep r colony afloat. Virginia was rly abandoned in 1614, but tobacco soon brought prosperity to the colony. It eventually became the economic backbone of the southeastern colonies despite strong opposition to reliance on this crop by the English king—and even by the founding colonial companies. The "sweet smell of gain" proved a potent force indeed, and although tobacco no longer dominates the economy of that region as totally as it once did, the tobacco industry still wields considerable force there and in other tobacco-producing areas of the world. And today, the tobacco market has a new dimension. On top of traditional public demand for tobacco, scientific image manipulation is used by the industry to try to create an ever larger market.

The popularity of one or another form of tobacco use has varied as standards of fashion have changed. Beginning in eighteenth-century England, for example, and for almost the next hundred years, the practice of sniffing snuff all but replaced the smoking habit. In this century, however, cigarettes have nearly everywhere edged out pipes, cigars, snuff, and chewing tobacco as the medium of choice. Unfortunately, cigarette smoking is probably the most dangerous of all forms of tobacco use.

Skillful marketing by the cigarette companies undoubtedly helped sell the public on cigarettes during the early twentieth century. But the power of advertising alone cannot completely account for the symbolic value with which cigarettes have been invested. Simple tubes of tobacco have come to represent modernity, *savoir-faire,* and, in the minds of children, who for decades have plunked down nickels for candy cigarettes and bubblegum cigars, adulthood. Hollywood may be one culprit. Humphrey Bogart would not be Humphrey Bogart without a cigarette drooping from his mouth, and the example of Lauren Bacall asking, "Got a match?" helped identify cigarettes as an essential social crutch. Even Bogart's death from cancer of the esophagus cannot dampen the identification of cigarettes with success and glamour that his movies and countless others continue to foster. In contemporary Soviet films, comments the satirical Moscow magazine *Krokodil,* "when an actor handsome like Apollo . . . takes a cigarette into his fingers, it isn't accidental. It means the time has come for a director to demonstrate that his character can also think."

Only recently has the compilation of an awesome medical case against cigarettes begun to tarnish the social sheen of smoking. Many thoughtful doctors had long suspected that cigarettes promoted ill health, but proof eluded researchers until the mid-twentieth century. Even in the early 1900s, cigarette advertisers could claim with impunity that their products actually promoted better health.

A startling jump in the number of lung cancer deaths in North America and Europe provided the first widely accepted proof of the hazards of smoking. In the nineteenth century lung cancer was relatively rare, but in the twentieth it rapidly emerged as the leading cause of cancer death in many countries. By 1950, studies in England and the United States showed an exceptionally close correlation between personal smoking habits and the incidence of lung cancer. By 1953, the prestigious *New England Journal of Medicine* could characterize the evidence linking cigarettes and lung cancer as "so strong as to be considered proof within the everyday meaning of the word." Then, in 1954, British and American

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researchers independently established that smokers have a markedly higher over-all death rate than nonsmokers. Yet the habit continued to spread, especially among adult females and teen-agers, who had lagged far behind adult males in adopting the practice, as well as among the wealthier classes in Africa, Asia, and Latin America.

In the early 1960s, two landmark public documents, which crystallized the evidence on the effects of smoking on health, caused something of a turning point in the social history of tobacco. Both a report released in 1962 by Britain's Royal College of Physicians and one published in 1964 by the Surgeon General of the United States presented the massive and growing medical case against tobacco. These and other, similar documents prompted some governments to educate people about the hazards of smoking and to place partial restrictions on cigarette advertising. As a result, the word on smoking's risks has now been fairly effectively disseminated, in the industrial countries at least. Most persons, even most heavy smokers, realize that smoking very possibly shortens their lives.

The most widely recognized health consequence of smoking is probably the heightened risk of lung cancer. The smoking–lung cancer connection is well known simply because avoidable lung cancer takes hundreds of thousands of lives around the world each year. Lung cancer deaths are much more common among males than females, but the gap is narrowing as the rise in female smoking, which began a quarter of a century ago, begins to make itself felt.

Past studies have shown that cigarette smokers are at least ten times more likely to develop lung malignancies than nonsmokers. (Those smoking newer, low-tar cigarettes may face a somewhat lower, but still dramatic, rise in lung cancer risk.) Many researchers feel that tobacco is responsible for eight or nine of every ten lung cancers. Combinations of tobacco smoke with air pollution or with toxic substances in workplaces undoubtedly add to the cancer toll; tobacco smoke and certain other pollutants operate together to drastically multiply disease risks. For example, male asbestos workers who smoke have 92 times the lung cancer risk of males who neither smoke nor come into regular contact with asbestos.
But cigarettes alone almost certai
account for most lung cancer cas
Gio B. Gori, deputy director of
Division of Cancer Causes and P
vention of the U.S. National Can
Institute, estimates that smoking t
packs of cigarettes a day for a y
exposes the lungs to nineteen tir
more benzopyrene—one of the po
ble carcinogens in cigarette smok
than they would receive from brea
ing the polluted air of Los Angeles
a year.

Other organs and tissues, besi
the lungs, become especially canc
prone in chronic smokers. The sm
ing of pipes or cigars, as well as pu
ing on cigarettes, raises a perso
odds of developing cancer of
mouth, throat, or voice box, parti
larly if the smoker is also a hea
drinker. Cigarette smoking also m
tiplies the smoker's chances of dev
oping cancer of the esophagus, pa
creas, and bladder. But, more f
quent and more deadly than th
other malignancies, lung can
poses a greater threat to the smoke
life than all the other smoking-
duced cancers together. After cons
ering the entire spectrum of canc
and what is known about their caus
the president of the American Can
Society recently stated: "Wipe
smoking and you eliminate some
to 20 percent of *all* cancer deaths
this and many other countries."

Despite the publicity that the ci
rette–cancer connection has receiv
far more deaths arising from cigare
smoking involve coronary heart d
ease—the leading killer in most
veloped countries—than canc
Smoking taxes the heart: a midd
aged American male who smokes
twice as likely as a nonsmoking m
to suffer a heart attack. Female sm
ers experience a less marked but s
significant increase in the odds
having a heart attack. Moreov
smoking combines with other ma
risk factors, such as high blood ch
lesterol and high blood pressure,
multiply manyfold the heart dise
risk for both sexes.

The intense search for carcinoge
in tobacco smoke has exposed t
as the principal agents provocateu
Research on the heart and circulat
system, however, suggests that
other smoke constituent—name
carbon monoxide—influences co
nary death rates. When males w
heart conditions are experimenta
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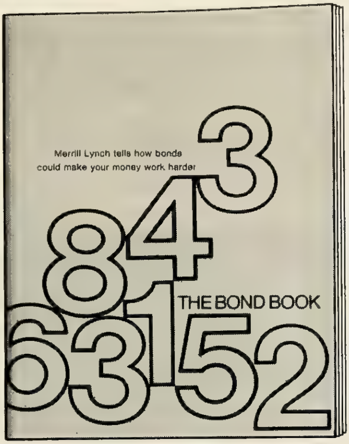
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concentrations, the chest pains of angina pectoris begin after less exercise than usual and persist longer than usual after exertion has stopped. Coronary patients have a limited capacity to supply their hearts with rich blood; exposure to carbon monoxide further reduces this capacity by impeding the transfer of oxygen from the blood to body tissue. Thus, carbon monoxide pollution places an added strain upon the heart and increases the likelihood that those already susceptible to heart attacks will experience them. (Nicotine inhalation seems to have the same effect.) Chronic heavy exposure to carbon monoxide may also promote the initial development of atherosclerosis, which, over time, can lead to heart attacks. Studies show that lifelong smokers tend to have more severe coronary atherosclerosis than nonsmokers do, and animals exposed to carbon monoxide develop higher blood cholesterol counts and more atherosclerosis than unexposed animals.

Sir Walter Raleigh and admirer

New York Public Library

Not surprisingly, cigarette smokers take on tremendously increased risks of developing long-term respiratory ailments such as chronic bronchitis and emphysema. Charged with causing tens of thousands of deaths and far more disabilities each year in Europe and North America alone, these diseases have emerged as recognized public health problems only during the last century. The twin onslaught on the lungs posed by industrial air pollution and tobacco smoke undoubtedly explains why chronic respiratory diseases are growing in frequency. But cigarettes seem to be the major contributor. Cigarette smokers are five times as likely as nonsmokers to die from chronic bronchitis or emphysema.

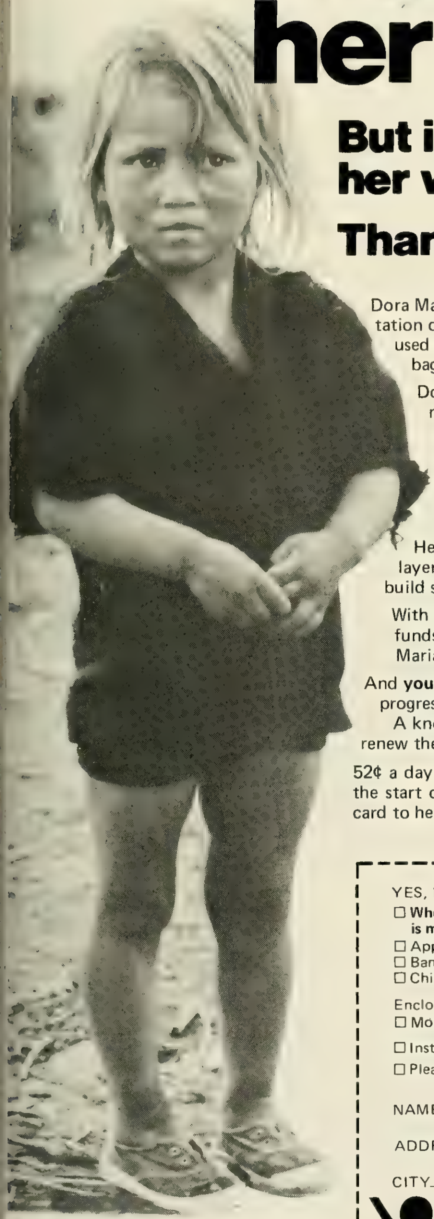
Perhaps the most telling of all evidence against cigarettes arises from a simple comparison of annual death rates between smokers and nonsmokers. The famous 1964 U.S. Surgeon General's report noted that the death rate of males smoking ten to nineteen cigarettes daily is 70 percent higher than that of nonsmokers. For those smoking forty or more cigarettes daily, the death rate is 120 percent higher. Nearly half the excess—and presumably avoidable—deaths that occur among smokers in a given year result from coronary heart disease, while more than one-sixth are caused by lung cancer.

Since the major medical indictments of smoking appeared in the 1950s and early 1960s, further evidence that raises questions about human rights has accumulated. Voluntarily inhaling carbon monoxide and carcinogens is one thing; exhaling them into the air that others are forced to breathe is quite another. In a smoky room or car, nonsmokers inhale tars, nicotine, and carbon monoxide just as smokers do, and both groups register at least temporary changes in their bloodstreams. Breathing the exhaust of smokers can strain the heart of a coronary patient who does not smoke.

But the most potentially tragic victims of cigarettes are the infants of mothers who smoke. They are more likely than the babies of nonsmoking mothers to be born underweight and thus to encounter death or disease at birth or during the initial months of life. In an otherwise supportive environment, the infant is usually well equipped to withstand the impact of
maternal smoking. But when o
factors that imperil the newborn
present, for instance, poverty or p
maternal nutrition, heavy smokin
the mother nearly doubles the infa
odds of dying within a month of bi
Moreover, whether or not they
born underweight, the infants
smoking mothers suffer more cl
infections, such as bronchitis
pneumonia, than other infants.

Many persons have extinguis
their last cigarette after learning of
health consequences of smoking
the United States the proportion
cigarette smokers among the a
male population has fallen from
percent in 1964, the year in which
Surgeon General's report appea
to 39 percent in 1975. Among a
females, the proportion of smo
fell from a high of 34 percent in 1
to 29 percent in 1975. In Great Bri
and several other countries, smo
have also shrunk in number. As a
ond-best response to the perils
smoking, still other new and vete
smokers now buy cigarettes with r
tively low amounts of tar and ni
tine. The figures, then, show a sig
icant, although hardly revolution
reversal of smoking trends in som
the more developed countries. T
also show that the decline in smok
has been especially marked am
those with the most education. In
United States, half of all college g
uates who have ever smoked re
larly have dropped the habit.

The over-all downturn in U
smoking rates has been marred, h
ever, by a notable exception—
that accounts largely for the slight
crease in over-all per capita cigar
consumption since it hit its lov
point in recent history in 1970.
precedented numbers of teen-
girls and young women now smo
Urged on by the continuing effort
tobacco advertisers to identify sm
ing with women's liberation, yo
women are narrowing the historic
between male and female smok
rates. In fact, in the 15- to 16-y
old age group, a slightly hig
proportion of girls (20 percent) t
boys (18 percent) now smo
Twenty-seven percent of all teen-
girls in the United States now sm
regularly and the number is climb
here and in many other countries
trend that a World Health Org
zation committee has found es
cially troubling in light of "the c
finding that smoking during pr
nancy has adverse effects on



Disaster is her way of life.

But in the next moment her world can begin to change.

Thanks to you.

Dora Maria's world is a cluster of cardboard shacks and lean-tos, ringed by sanitation ditches where sewage flows openly next to the street. It is built on what used to be a city dump. Everywhere, there is the stench of decomposing garbage. And the air is thick with flies.

Dora Maria plays in the waste as our children play in sandboxes. She does not notice stench. Flies light on her face and nestle in her hair. She does not bother to brush them away. She doesn't think of store-bought dolls, new dresses or hot baths. The life she is leading is the only one she knows.

But for 52 pennies a day, you could sponsor a child like Dora Maria through Save the Children. And things could begin to change for her and her entire village.

Her people are spirited and eager to work. They dream of better times. Of layering the area with topsoil. Of carting in lumber, making adobe blocks to build solid, livable homes. Of a school, medical and sanitary facilities.

With your help and that of other sponsors, Save the Children can provide the funds and guidance to make these dreams come true. And children like Dora Maria can have a new chance at life.

And **your** family gets so much too. A photo of your sponsored child, letters and progress reports. A caring relationship with a family and community far away. A knowledge that you have helped hardworking people retain their dignity—renew their hope.

52¢ a day may not be much to you. For Dora Maria and her village, it could be the start of a miracle. Won't you please fill out and mail the attached response card to help a child like Dora Maria and her village.

If attached mailer has been removed, use coupon at right.

NH 4/7

YES, I wish to sponsor a ☐ boy ☐ girl ☐ either

- ☐ **Where the need is most urgent**
- ☐ Appalachia (U.S.)
- ☐ Bangladesh
- ☐ Chicano (U.S.)
- ☐ Colombia
- ☐ Dominican Republic
- ☐ Honduras
- ☐ Indian (Latin America)
- ☐ Indian (U.S.)
- ☐ Indonesia
- ☐ Inner Cities (U.S.)
- ☐ Israel
- ☐ Korea
- ☐ Lebanon
- ☐ Mexico
- ☐ Rural South (U.S.)

Enclosed is my first payment:

☐ Monthly, $16 ☐ Quarterly, $48 ☐ Semi-annually, $96 ☐ Annually, $192

☐ Instead of becoming a sponsor, I am enclosing a contribution of $__________.

☐ Please send me more information.

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ADDRESS______________________________

CITY_______________STATE__________ZIP__________

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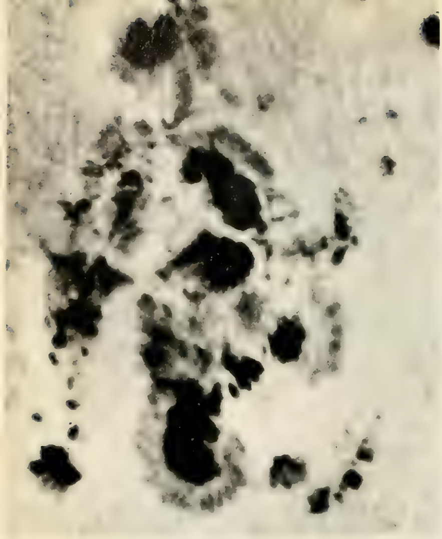

QUESTAR PHOTOGRAPHS THE FACE OF THE SUN

This photograph, taken some years ago during a peak of solar activity, not only shows great detail in the enormous sunspot, but reveals the "orange peel" or "rice grain" texture of the surface, so familiar to experienced sun observers.

Photographing the sun's detail, with its granulations that measure only 1 to 2 seconds of arc, should be a job for the great mountaintop observatories, where a giant telescope can avoid sighting through the worst of the earth's heat-agitated air. However, this picture was taken with the 7-pound portable Questar at midday, right through the earth's entire atmosphere, at sea level! Exposure, 1/1000 second on 35 mm. Microfile film; effective focal length over 50 feet. Our photographic print fails to show all the beautiful tracery so plainly visible on the negative.

For totally safe observation of the sun, Questar 20 years ago developed its patented filters which keep more than 99% of the damaging heat and light from entering the telescope. This was the first thought anyone had given to keeping these rays out of the instrument itself since Galileo sighted through his first telescope in 1609!

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fetus." If, as one familiar cigarette advertisement patronizingly chants, women "have come a long way," their equality with men as smokers may lead to nothing more "liberating" than premature death.

Although the percentage of its population that smokes is somewhat smaller than it was a decade ago, the United States retains its long-standing title as the world's premier cigarette-smoking country. This is partly because so many Americans smoke and also because they tend to smoke more cigarettes per day than do most other smokers. About 2,750 cigarettes were smoked in 1974 for every person in the country. Only Japan, with a 1974 per capita consumption of 2,600 cigarettes, came close to the U.S. average. Astonishingly enough, 70 percent of all Japanese males smoke, although only 9 percent of Japanese females do. Annual per capita cigarette consumption in Western European countries ranges from 1,000 to more than 2,000; average consumption in Mexico is more than 700 a year; and per capita consumption in poor African countries, such as Nigeria and Tanzania, is still only a few hundred cigarettes per year.

These national cigarette-consumption averages provide little hint of the present smoking pandemic. While the incidence of cigarette smoking may have peaked in some of the developed Western countries, the practice has entered a dramatic growth phase in most of the less-developed countries. Cigarettes are catching on especially quickly in the cities of the poor countries. A recent Pan-American Health Organization survey in eight urban areas of Latin America revealed that 45 percent of males in those cities smoke: a higher percentage than in the United States. In contrast, only 18 percent of the females in these major Latin American cities are smokers. To capitalize on this new growth, the major cigarette companies are now as never before aiming their promotion at markets in the developing countries.

Cigarette smoking is not yet the national pastime in most of Africa and Asia that it is in Latin America, partly because average personal incomes in Africa and Asia are generally much lower than those in Latin America. Ironically, however, just when the smoking habit is being dropped by record numbers of the better-educated and better-off individuals in North America and Western Europe,
the educational and economic e
of the world's poorer countries
leading their countrymen in takin
the practice. Data from In
Uganda, and elsewhere show
cigarette smoking is especially p
lar among university students
hand or mouth, the cigarette in t
countries bespeaks privilege
knowledge.

Perhaps the chief constraint on
arette use in poor countries is mo
only the rich can afford to enjoy r
than an occasional smoke. As
comes in Africa, Asia, and L
America rise, however, both
number of smokers and their smol
frequency climb as well. Rapid
come growth usually affects smol
rates perceptibly; oil-rich Mi
Eastern countries are providing c
rette merchants with a hot new r
ket. In Nigeria, lung cancer is
rare, but a medical professor at La
University warns that "lung ca
will emerge with the affluence
erated by our country's oil econo
there will definitely be more mc
for cigarettes."

Smoking in poor countries is
totally confined to urban areas.
bacco use has long been entrenc
in some rural regions. For exam
shredded tobacco for hand-rolled
arettes or pipes is a stock iten
every Indonesian marketplace.
China, the amount of tobacco gro
in backyard plots for personal c
sumption probably rivals the ou
of the vast state-run tobacco indus
Contemplating the dim nutritio
prospects of the Gurung, a hill t
of Nepal, an anthropologist rece
wrote that, faced with a finan
pinch, the tribespeople would pr
ably let themselves become "m
nourished rather than give up cer
'luxury' goods such as cigarettes

Who profits from the tobacco b
ness? The long list of those wit
financial stake in the cigarette tr
includes private and governmental
bacco farmers, huge transnatio
private cigarette companies and sta
owned cigarette monopolies, lo
and national governments t
depend in part upon tobacco-g
erated taxes and foreign exchange
survive, and the thousands of ne
papers and magazines whose pro
derive in part from the cigarette
vertisements they carry.

The two leading tobacco-grow
countries are the People's Republi
China and the United States; Inc
the Soviet Union, and Brazil co

t but lag way behind. The world's or cigarette producers are, in er, the Chinese government mo- oly, the British-American To- co Company, the Soviet govern- it monopoly, the Japanese gov- ment monopoly, and Philip rris Inc. Hence three of the top cigarette producers are public, ier than private, enterprises.

he nearly free functioning of cig- te companies in capitalist coun- s is predictable. But the seemingly hecked power of tobacco interests the governments of controlled- ket economies, such as China the Soviet Union, is puzzling, ticularly since both of those gov- ments so strongly emphasize pre- tive medicine. While the Soviet ernment is at least trying to dis- rage smoking through public edu- on, the Chinese government has ie nothing to uproot the habit. ien hunger and unsanitary living ditions were the overriding health llenges in China, an anticigarette campaign probably would have been a luxury. But now, following China's dramatic success in reducing undernutrition and infectious disease, cigarette-induced ailments are on the increase. Admittedly, antismoking campaigns would probably strike the Chinese as hypocritical, since many powerful national leaders—including the late Chairman Mao—are heavy smokers. But upon his recent return from a visit to China, a U. S. Senate staff member offered a second explanation: the large tax on cigarette sales "serves as a major source of investment capital for the central government—a source not easily replaced and therefore not lightly abandoned."

Many governments must view the tobacco trade with mixed emotions. As they boost cigarette and tobacco taxes and import duties—often ostensibly to discourage smoking—governments simultaneously create a major source of revenue that is far easier to justify, politically, than increases in other kinds of taxes. In many countries, the tax revenue from tobacco products exceeds the amount received by the farmers for the original tobacco crop. In 1974 in the United States, federal, state, and local governments took in about $6 billion in taxes on tobacco products, while the $4 billion in tobacco taxes received by the British government in that year constituted 70 percent of consumer expenditures on cigarettes. Even in Nigeria, where smoking's grip is less well established, tobacco taxes provided 2.2 percent of all the tax income in 1969/70.

York Public Library

Held hostage to the political power of the tobacco and cigarette producers or lured by self-interest in the tobacco business or both, many governments actively subsidize tobacco production. Samuel Epstein, a physician whose specialty is environmental health, calculates that the U.S. Department of Agriculture spends about $50 million annually on price supports, tobacco research, export promotion, and other programs that support the tobacco industry. The nation's Agricultural Research Service, he notes, "assigns more space to research on tobacco than to research on food distribution. What's more, the ARS's concern is to produce a more marketable product, not a safer product."

Governmental hypocrisy in the treatment of tobacco becomes especially easy when tobacco and cigarette exports are involved. Foreign exchange is always welcomed by economic planners, and in this case, the negative health results are someone else's concern. To help keep Italy's tobacco exports competitive outside the European Economic Community, the EEC provides a subsidy of about ten cents for each pound of tobacco sold. The U.S. government ended its direct export payments in 1973, and terminated its practice of sharing equally with producers the costs of export promotion in 1975. But the federal government still finances tobacco booths at foreign trade fairs and trips of tobacco experts to and from the United States.

Perhaps the oddest and most questionable use of tobacco by the United States has been the inclusion of tobacco in the Public Law 480 "Food for Peace" program of concessional agricultural sales to needy countries. This supposedly humanitarian aid program has been manipulated to meet several goals at once: to get rid of domestic tobacco surpluses, to introduce foreigners to U.S. tobacco in the hope of nurturing a future commercial market, and to provide economic aid to politically favored governments. The amount of tobacco shipped on easy terms under P.L. 480 has ranged in value from $17 to $35 million a year over the last decade, with the bulk going to areas of "national security" concern, such as South Vietnam, Cambodia, and, most recently, Egypt.

Those who design, print, or broadcast cigarette advertisements also benefit from the tobacco business. Far from reducing promotional fever, the ban on advertising cigarettes over television and radio in the United States and several other countries merely provided a windfall for the print media. The entire $250-million advertising budget of the American cigarette companies now goes totally to magazines and newspapers. Only a few major U.S. periodicals have refused to share in this money.

The mainstays of the tobacco business are, of course, the hundreds of millions of tobacco consumers—those who pay for both the pleasures and the lethal consequences of tobacco use. Social forces encourage people to start smoking and to cling to the habit, but the $85 to $100 billion that consumers spend each year on cigarettes is what sustains global cigarette production and trade.

In the ambiguity-plagued universe of environmental health studies, only rarely does proof emerge of an unequivocal link between a particular environmental agent and a particular disease. The airtight medical case against cigarettes stands out sharply as an exception. Cigarettes, therefore, explicitly challenge the capacity of societies to use the conclusions of health research to improve daily life. The selective vision of cigarette company executives and the smokescreen of cigarette advertising notwithstanding, today's meaningful debate is not over the possibility that cigarettes might be a public hazard—the only question concerns eliminating a proven hazard.

But decreasing the hold of cigarettes is no simple task. Pollution from cigarette smoke, unlike impure water or industrial wastes in the air, results primarily from personal decisions. Smoking, overnutrition, dangerous driving, and other forms of self-destruction are all health problems rooted in personal behavior, problems that often leave health officials perplexed and frustrated. Many persons with knowledge of the risks involved still persist in unhealthy behavior. How can public health officials influence them? Draconian interventions into people's lives might reduce smoking to a minimum, but at a social price few are willing to pay.

From childhood onward, people are constantly bombarded with subtle and not-so-subtle enticements to smoke; advertisements that associate cigarettes with sexual success are reinforced by what is probably a far stronger influence—the example set by countless smoking adults. Once they become smokers, individuals grow both psychologically and physiologically dependent on cigarettes. Although teen-agers may start smoking out of a desire to appear sophisticated and mature, they may continue long after that motive has lost its relevance because they are hooked on nicotine, an addictive drug.

The full social cost of cigarette smoking has never been calculated, but the purchase price of cigarettes, the extra medical expenses incurred by smokers, and the income that smokers sacrifice to unnecessary disease and premature death constitute only a portion of the total cost. A 1975 report to the Massachusetts Public Health Association estimated that Massachusetts smokers alone cost the state's general public more than half a billion dollars a year. If no one in the state smoked, fire protection costs would fall by at least $18 million and fire damage by at least $24 million a year. State medical costs provided from public funds or health insurance to treat smoking-induced diseases are $220 million a year. Production losses in the state totaling $260 million a year result from the working time missed because of smoking-related disease.

The cost of cigarettes includes, in addition to the above factors, the many hundreds of millions of dollars in public funds spent around the world each year on research on smoking-related cancer, heart, and respiratory diseases. Moreover, nonsmokers generally pay higher life insurance rates than they would if smokers were not included in the actuarial tables. The health hazard inflicted upon innocent bystanders provides another critical justification for government intervention to deter tobacco use.

Over the last few years many local and national governments have, in
fact, restricted public smoking. M
cow recently banned smoking in
city's restaurants, while smokin
public buildings and transporta
has been limited or prohibited
many parts of the United States
Europe. Such laws are often laxly
forced, however. Interestingly, m
than half of all current smokers po
in the United States in 1975 agr
that cigarette smoking "should be
lowed in fewer places than it is now

Governments can weed out m
contradictions from their present p
icies by ending subsidies to the
bacco industry. But in the end,
only way to solve the smoking pr
lem is to steer young people aw
from the habit and to help older sm
ers kick it. The vigorous, systema
use of all possible educational ch
nels, advertising restrictions, pro
nent warnings on cigarette packag
tax disincentives, and so on mi
radically alter the smoking scene.

A different approach to the pr
lem is to press ahead with the sea
for cigarettes that are lower in ta
carbon monoxide, and other to
gases. Both the cigarette compan
and the U.S. government are now
volved in research toward that en
While opinions differ as to wheth
public funds ought to be diver
from antismoking campaigns in
such research or whether all such e
penses ought to be borne by the p
vate companies, safer cigarettes c
undoubtedly reduce the health co
of smoking. The two goals, a no
smoking society and less harmful c
arettes, need not be viewed as cont
dictory; both can be pursued at on

In the world's more develop
countries, personal behavior h
emerged as the dominant influence
health. The relevant personal choic
are, in turn, influenced by the preva
ing social and political environme
Societies cannot and, most wou
agree, should not try to dictate me
cally rational behavior to each in
vidual. But neither should they e
courage self-destructive behavior.
U.S. psychologist Daniel Horn, o
of the pioneers in the study of smo
ing and health, says, today's ch
lenge is "to identify the mea
whereby we can help people
whether children or adults—to d
velop the capability of understandi
the issues in personal-choice hea
behavior, and the capacity to ma
choices both in their own self-inter
and in the interest of society
large."

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ritt, and my son
rick at Matagorda
each. We come here
s often as we can."

"I think you can have both energy and a good environment, if you try to do things right."

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Hot Spots

Peter R. Vogt

st volcanic activity can explained by plate tonics. But some volcanic ions, such as Iceland and waii, are still puzzling

ieneral acceptance of the idea of tinental drift by geologists in the ted States dates only from the late 0s. The continents are now wn to lie embedded like rafts in d, thicker plates—fragments of earth's outer shell, or "lithoere," composed of the earth's st and the uppermost part of the ntle. The lithospheric plates move vly about relative to each other (an or two per year). The motion of e 50- to 100-mile-thick plates ses earthquakes, volcanic action, mountain building at the plates' es. Plate motion and its consences, including continental drift, grouped together under a unifying cept known as "plate tectonics." lthough now taken as virtual fact, e tectonics is still begging for a ing force, a mechanism that ves the plates. Most investigators or some sort of thermal convection e earth's mantle, the plates being ely the frozen skin on top of this gishly convulsing system. Plate onics explains the regular creation ew oceanic crust along the axis of the mid-oceanic ridge, where molten material wells up from within the mantle. It also explains the existence of curved festoons of volcanic islands like the Aleutians or the Marianas with their nearby deep-sea trenches and associated belts of intensive earthquake activity. These volcanic islands are surface expressions of oceanic plates descending into the mantle from which they were created tens or hundreds of millions of years before.

What plate tectonics by itself has not been able to explain is a collection of some dozens of relatively localized centers of intense volcanic activity, many of which are within the interiors of plates instead of at their margins. In this article, I refer to such localized volcanic areas as "hot spots." By that term I mean not only volcanoes of this type on the earth's surface but also the regions below them where the melting of volcanic material takes place. Although there appear to be more than 100 hot spots active at present on our planet, these spots do not expel equal amounts of material. Some discharge an average of more than one cubic mile of lava per century—most of it a dark, fine-grained rock called basalt—others less than one-thousandth as much. (Of course, centuries or even millennia may pass without any volcanic eruption at all.)

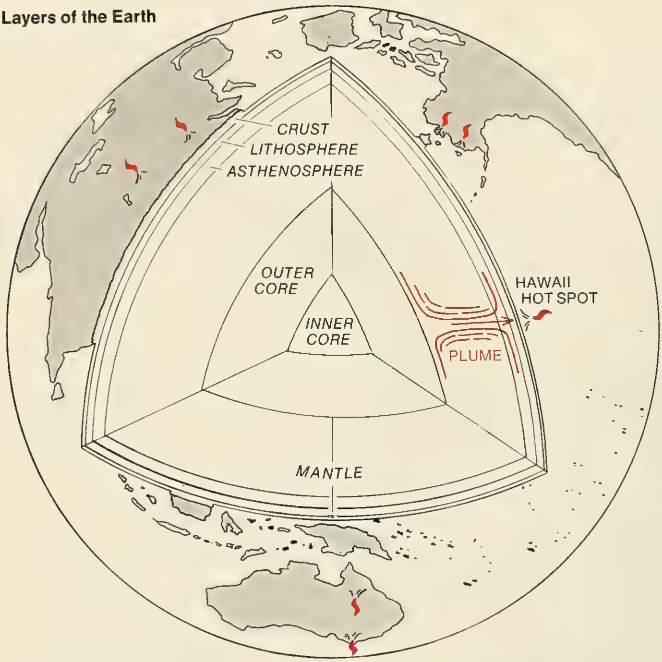
The most prominent hot spots currently active in the continental United States are in the area of Yellowstone National Park and the northeastern corner of New Mexico. Both are dwarfed by the hot spot at Hawaii. A map of the globe shows that the worldwide distribution of hot spots is not random. There are large "spotless areas" such as the western Atlantic and eastern North America. The distribution of hot spots does not correlate strongly with the continents or ocean basins but many prominent hot spots tend to be close to the mid-oceanic ridge.

The two most familiar and most spectacular examples of hot spots are Hawaii and Iceland. A detailed look at them may thus be the best way to approach the problem of what causes hot spots. It might at first seem outrageous to lump together two such seemingly diverse places: one, a necklace of green specks floating in the vast blue Pacific, which trails off in a westwardly direction from the towering volcanoes of the island of Hawaii—the "Big Island"—to deeply eroded smaller islands and finally to coral atolls and entirely submerged volcanic cones called seamounts; the other, a cold and stony hulk in the stormy North Atlantic, the emergent summit of a vast bulge of the Mid-Atlantic Ridge. But for all their differences, Hawaii and Iceland have several properties in common—both represent unusual and long-lived volcanic activity that dates back tens of millions of years and seems to migrate over the lithospheric plates with time. The volcanic activity of Iceland is unusual because it is several times greater than that occurring elsewhere along the Mid-Atlantic Ridge. And the copious volcanism of Hawaii is unusual because it occurs in the midst of a million square miles of volcanic quiescence, far from the nearest mid-oceanic ridge.

Iceland contains numerous volcanoes of various kinds and is one of the most active volcanic regions on earth. Most of its recent volcanic activity is restricted to a few belts that

auea, on the "Big Island" of waii, is the largest active cano in the world. From 2 to 1971 it ejected an rage of 60 million cubic ds of lava per year.

ing



Layers of the Earth

The earth's crust is a thin outer shell, 10 to 40 kilometers deep. The lithosphere, which includes both the crust and the uppermost part of the mantle, is the 50- to 200-km-thick rigid material of which the earth's drifting plates are composed. The next layer, about 500 km thick, is the semimolten asthenosphere over which the plates move. Below that are some 2,200 km of rocky mantle. Next is the 2,100-km liquid outer core and then the 1,370-km solid inner core.

extend northwest through the middle of the island. Rocks at the center of the island are new and young, but as one moves either westward or eastward away from the center, the rocks get progressively older, dating back fifteen million or more years at the eastern and western coasts. Massive submarine extensions of the island connect it to Greenland on the west and the Faeroe Islands in the North Atlantic on the east. These underwater extensions form a transverse ridge, perpendicular to the axis of the Mid-Atlantic Ridge. Where the transverse ridge emerges above sea level in Greenland and the Faeroes, volcanic rocks that erupted about sixty million years ago cap the ridge edges. Thus, whatever is causing the profuse volcanic activity on Iceland today has existed more or less continuously for sixty million years.

In the case of Hawaii, the islands west of the volcanically active Big Island get progressively older and volcanically deader. Whatever produced the Hawaiian chain and its continuation as the Emperor seamounts must have existed for at least the last seventy million years, since that is the age of the oldest surviving seamounts at the northern end of the chain. These seamounts will disappear when the leading edge of the Pacific plate that carries them descends into the deeper mantle below the Aleutian arc.

The progressive aging of volcanic rocks the farther away they lie from the area of recent activity is not a new discovery. The nineteenth-century American geologist James Dwight Dana deduced the effect in 1838 from his observation that the Hawaiian Islands are more eroded and less active volcanically the farther west one goes. It was not, however, until radiometric dating methods were applied to the Hawaiian Islands a century later, that Dana was proved correct. But the systematic aging in a certain direction could not itself be understood until plate tectonics came along in the mid-1960s. It was then that the Canadian geophysicist J. Tuzo Wilson conceived the basic explanation of the hot spot.

There must be a relatively fixed region of persistent mantle melting below the lithospheric plates, Wilson reasoned. This region, the hot spot,
produces batches of magma, or n
ten rock. (Some scientists use
term "melting spot" or "mel
anomaly" in place of hot spot.) Be
lighter than the surrounding rock,
magma makes its way upw
through the plate and flows out on
earth's surface in the form of
canoes. Plate motion slowly mo
the volcanoes away from the fixed
spot that formed them. Through
process, the Hawaii–Emperor ch
has become a seventy-million-ye
long "track" of the motion of the
cific plate over one hot spot. If
Pacific plate had been stationary
entire time, all the volcanic mate
created during seventy million ye
—more than 100,000 cubic miles
would have piled up in one place

Iceland straddles the Mid-Atla
Ridge. Its volcanoes thus deposit
salt on the two diverging Euras
and American plates. These plates
moving apart at the slow rate of
centimeters (about ¾ inch) per ye
The Pacific plate, by contrast, is m
ing at the relatively rapid speed
five to fifteen centimeters (about
to six inches) per year. This
ference in rate of plate motion pro
bly explains the squat shape of I
land and its submarine extensions
compared to the long chainlike c
figuration of the Hawaii–Emperor
lands, formed over approximately
same geologic period of time.

If plates move over hot spots,
the hot spots themselves move v
respect to the deeper mantle? Opin
on this question is divided. Data

ing to the last five to ten million rs indicate that hot spots have not ved, although information from l earlier times suggests that they e may have. In my view, hot spots parently do not move—or if they they generally move more slowly n lithospheric plates. This relative xity'' of hot spots was shown in 71 by W. Jason Morgan, a geoysicist at Princeton University, by ans of paleomagnetic data.

The magnetism in certain rocks isters the direction toward the th magnetic pole as well as the latde at which the rocks were origily formed. If the area in which the ks are currently found is part of a ving lithospheric plate, the magism in the rocks can provide intion about the motion of the plate. Morgan showed that hot spot traces d data on rock magnetism yield a nsistent picture of plate motion if cause of the hot spots is geoaphically fixed.

Hot spot traces have thus proved y useful in reconstructing the acl motion of the plates over the th with respect to the deep mantle. ate tectonics only describes the relve motions between plates. For exple, two plates might be moving art eastward and westward, but ile they are moving in this way relve to each other, both could be ving northward over the deeper ntle.

The relative fixity of hot spots had other and perhaps deeper signifince. It was one of the observations at led Morgan to make the mental mp from Wilson's hot spots to the a of thin columns of relatively hot aterial rising in the earth's mantle. ch such column, or "convection ume," expresses itself as a hot ot. Plumes possibly extending wn as far as 1,800 miles to the botn of the earth's mantle would not expected to shift rapidly about.

Morgan's hypothesis likened the umes to "thunderheads" in the antle. They were postulated as eas of rapid (2 meters, or 6½ feet, r year), narrow upward convection hot mantle material that spreads it in the upper mantle and then sinks owly in regions distant from the ace of origin to complete the conction circuit. This was a novel apoach to the old idea of mantle convection, according to which convection is not restricted to narrow zones but consists of wide cylindrical cells.

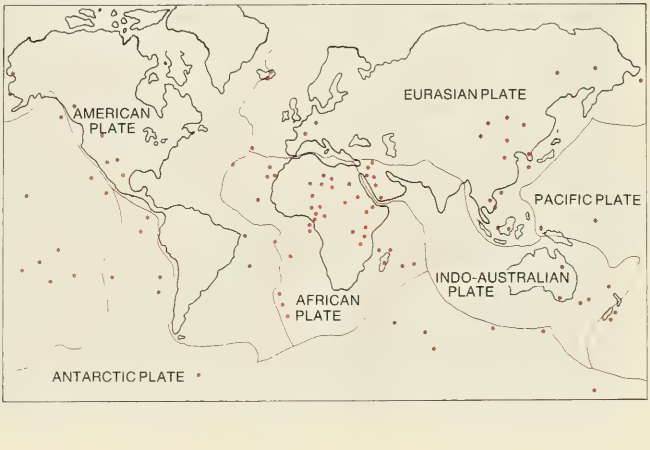
Alternative theories try to explain linear volcanic chains, like the Hawaiian Islands, in terms of gradually advancing fractures in the lithospheric plate, magma being thought to be potentially available everywhere at sufficient depth. In the Pacific, such fractures would have to extend southeastward and close up at the rear as they progress, otherwise there would be volcanic activity all along the chain. The hot but rigid rock of the lower lithosphere would be induced to melt when the fracture temporarily released some of the pressure of the overlying material.

Is there any way to prove that hot spots are really evidence of rising convection plumes? In Morgan's model, the top of the plume is in the soft, semimolten earth layer just below the lithospheric plates. This mushy zone is commonly referred to as the "asthenosphere." Plumes bring material up vertically out of the deeper mantle; at depths of about a hundred miles, the first tiny melt pockets develop in the hard but plastic rock. This partially molten "crystal slush" then moves radially outward into the asthenosphere, much as a glacier moves away from a mountain. The greatest amount of melting would occur directly above the rising plume, thus causing the observed volcanic activity at the hot spot. Although other theories about hot spots could also account for the volcanism, the outflow of molten material into the asthenosphere is a specific prediction unique to the plume model. The theory would receive support if such a flow below the plates could be measured.

In 1971, the same year Morgan introduced his mantle plume ideas, a research team from Columbia University published the results of a 1966 geophysical research cruise to the Reykjanes Ridge off the coast of Iceland. Their measurements suggested to me the possibility that flow below the plates—specifically, flow away from the Iceland hot spot—*could* be measured and used to demonstrate that Morgan's mantle plume theory is valid.

Projecting southwest from Iceland, the Reykjanes Ridge forms a northern extension of the Mid-Atlantic Ridge. The Reykjanes Ridge has a crestal zone of elevated volcanic topography close to the line where new magma is coming up. This "line" is a narrow zone, no more than a few miles wide, where new crust is being added to the steadily diverging American and Eurasian plates, to the accompaniment of frequent earthquakes and submarine volcanism. The crestal zone of the Reykjanes Ridge shoals gradually northeastward and then emerges in Iceland as Reykjanes, a peninsula. The capital city of Reykjavik, on the peninsula, is on the very edge of the American plate, on ocean crust so young and hot that geothermal waters can be tapped only a few hundred to a few thousand feet below the surface. Reykjavik is heated by these waters. A few miles to the

The World's Active Hot Spots



southeast one can walk along the lava flows of the newly born "ocean crust" of Reykjanes and across to the Eurasian plate, of which eastern Iceland is a part. In addition to the Reykjanes Ridge crest, there is a second young volcanic belt—one that includes such famous volcanoes as Hekla, Katla, Surtsey, and Heimaey—still farther east. It appears that the line demarking sea-floor separation is in the process of shifting to the eastern zone of volcanoes. If so, the volcanic fires of Reykjanes may someday—perhaps in a million years—be stilled. Shifts such as the above are not too common in the world ocean; the fact that many of the known shifts have occurred near hot spots tends to lend credence to the plume theory. Outward flow from plumes could help break plates apart or weaken them so much that other forces could separate them.

If there is a flow below the plates, does it spread out evenly in all directions? Probably not. Since plates get thicker with age—at the expense of the underlying soft layer—a natural conduit is formed below the mid-oceanic ridge. Much of the plume flow would be channeled into this "pipe"; irregularities in the flux leave a record of flow speed imprinted like frozen wakes on the ocean crust. The mid-oceanic ridge and the pipe below it are displaced at major fracture zones. Such displacements would block or interrupt the flow in the mid-oceanic pipe to various degrees. The result of these new discoveries is a complex plumbing system wherever plumes exist below the mid-oceanic ridge, for example, near Iceland, the Azores, or the Galápagos Islands in the Pacific.

Independent verification of flow below the crest of the Mid-Atlantic Ridge and even of damming at transform faults—fractures in the earth's crust that tend to run at right angles to the ocean ridges—has emerged from the geochemical studies at the University of Rhode Island, which found Icelandic volcanic rocks derive from a distinct plume-type mantle. As the mantle flows under the Reykjanes Ridge, it becomes mixed with "normal" mantle, that is, mantle distant from plumes, with the result that basalts dredged along the Reykjanes Ridge become progressively less "Icelandic" in their chemistry as distance from the hot spot increases. North of Iceland the Icelandic chemistry disappears abruptly across a major fracture that is displaced from the axis of sea-floor spreading. This abrupt cutoff of rock of Icelandic-type composition can be explained if northward flow from the Icelandic plume has been dammed at the fracture.

Are there any other measurements we can make of what is going on below the plate in the deep mantle, other than of the particular topography found near Iceland, that might help us understand the cause of hot spots? If hot spots are mantle plumes that extend upward from their origin at great depth, one might expect the rising material to differ somewhat in its physical properties from that in the surrounding mantle. If so, seismic waves generated by earthquakes or atomic explosions might be slowed or bent as they passed through different materials in the rising plume. Since a plume is very narrow on the scale of the earth, an earthquake would have to occur at just the right location, with respect to the seismograph, for the waves it generates to intercept the plume. To date, there have been some reports that seismic waves generated in the western Pacific island arcs and recorded in western Canada have been affected by anomalous conditions as they passed above the earth's core–mantle boundary directly under Hawaii. But several investigators have disputed these interpretations, and the question of whether the physical properties of the mantle are distinctive at great depths in the mantle below the area of current hot spot volcanism is an open one.

Seismology can only indicate the present state of the earth. What we should really have is a historical index of activity that shows, for example, how many cubic miles of mantle the plume brings upward per year over periods of geologic time. Needless to say, there is no direct way to measure the upward flow in a mantle plume. However, the average annual rate of lava and ash poured out by a hot spot's volcanoes can be measured. To compute from this measurement the volume of mantle brought up, we would have to know
what fraction of mantle actually m
and escapes to the earth's surfa
The chemistry of the basalts invol
indicates that the rate of volcanic
charge needs to be multiplied by a
where from 10 to 100 to give the
ume of mantle that produced the la

There are two possibilities for e
mating volcanic discharge rate. Fi
the volcanoes can be monitored
the volume of erupted rocks me
ured directly after each erupti
Since volcanoes are notoriously
ratic—many years may elapse
tween eruptions—a long histori
observation record may be necess
to establish a geologically meani
ful, long-term average eruption ra
Accurate records of measu
erupted rocks are a recent devel
ment. On Hawaii, where the v
canoes discharge copiously, accur
lava flow measurements extend ba
only to the last century. The curren
most active volcano is Kilauea on
island of Hawaii: over the per
from 1952 to 1971, Kilauea d
gorged an average of 60 million cu
yards of lava per year. Since the ea
nineteenth century, the average co
bined annual discharge of Kilau
and Mauna Loa has been about
million cubic yards, but this must
considered a lower limit since littl
known about nineteenth-century su
marine eruptions. During actual eru
tions, the discharge rate of lava m
be hundreds of times higher,
course, just as rainfall rates may
much higher during a storm than ra
averaged over a year.

The second way to estimate v
canic discharge rate—one I ha
made use of—begins with divid
the Hawaiian chain into fifteen-mi
wide strips running across the ch
from the southwest to the northea
The volume of volcanic topog
phy—that is, islands, submerged
land bases, and seamounts—abo
the abyssal sea floor was calcula

When the Helgafell volcano
the Icelandic island of Heima
erupted in January 19
houses in the fishing villa
of Vestmannaeyjar were alm
buried in volcanic as

each strip. The volume was then
ded by the time it took the plate
ove across the fifteen miles of the
). The time was derived from the
s of various volcanic islands and
nounts along the Hawaii–Em-
r chain.

he measured discharge rate for
vaii, as ascertained by the first
hod, is astonishingly close to the
res I arrived at using the second.
s correlation suggests that if the
2 to 1971 discharge rate had ap-
d from one million B.C. onward,
observed volume and oldest ages
he Big Island of Hawaii can be
ounted for. We do not know
ther or not there are large fluctua-
s in basalt discharge over time pe-
ls measured in centuries or in
usands of years. If there are, the
nt historical rate happens, fortui-
sly, to equal the long-term, or mil-
-year average. On the other hand,
possible that a hot spot's volcanic
out over centuries and millennia is
tively constant, in which case a
decades or a century of observa-
will provide a good approximation of the million-year average.

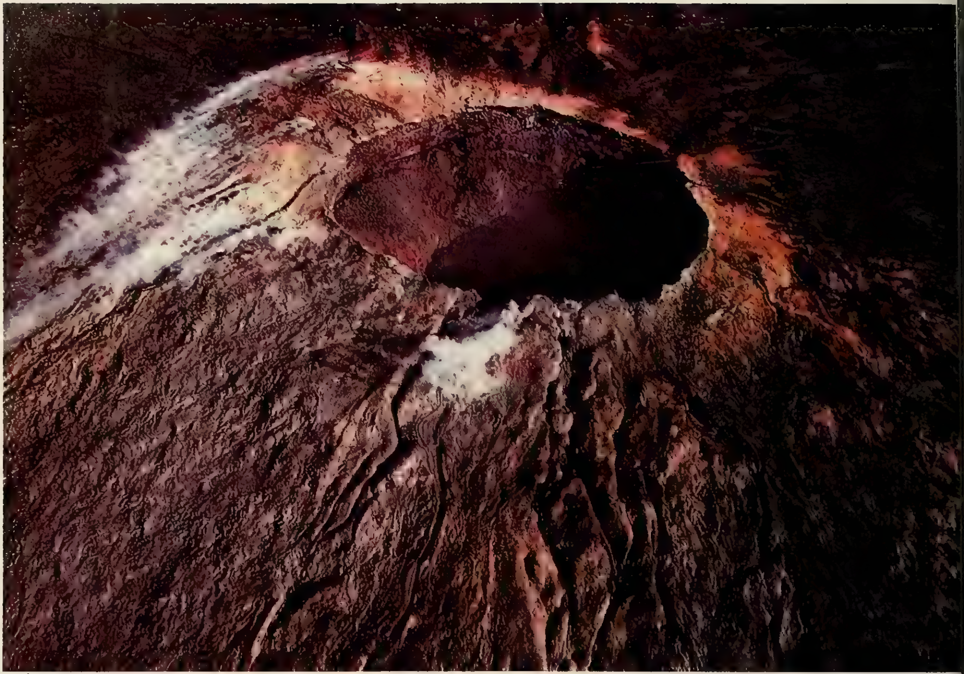
But when we examine the output of the Hawaii hot spot over still longer timé periods—say, ten million years—it is no longer true that productivity can have remained constant. Since there are now numerous rock age dates along the Hawaii–Emperor chain, the massive portions of the chain around Gardner Pinnacles, west of Niihau, and, likewise, between Oahu and Hawaii seem to represent a higher than average lava discharge rather than slowdowns of the Pacific plate. (If a plate slows down while discharge remains constant, we should also expect the volcanic chain to become more massive.) The topography of the Hawaiian Islands clearly shows a progressively increasing discharge that began about six million years ago—the time when Kauai and Niihau islands were formed at the geographic site currently occupied by the Big Island, namely, over the Hawaii hot spot. The Big Island is aptly named—I cannot think of a larger, purely volcanic island, either visible or sunk below the sea, with the single exception of Iceland. And Iceland is largely a bulge in the ocean floor itself, not a volcanic edifice constructed, lava flow by lava flow, from the abyssal depths. In terms of the surviving seventy-million-year volcanic trail left on the Pacific plate by the Hawaii hot spot, the "geologic present"—that is, the last one or two million years—has been truly exceptional.

What about the discharge rates of other hot spots around the world? Most are less well known than Hawaii and less plentiful in their volcanic output. I have compiled discharge histories of a number of hot spots, with the following surprising result: There seems to be a globally synchronized waxing and waning of volcanic discharge rates at widely spaced hot spots. For example, the twelve- to eighteen-million-year-old peak in discharge rate that produced the massive part of the Hawaiian Ridge near Gardner Pinnacles and French Frigate Shoal corresponds in time to the extrusion of the vast Columbia basalts in Oregon by a hot spot at present

Turner

Iceland's Helgafell volcano had been quiescent for about 5,000 years before it suddenly exploded in 1973 to the surprise of local residents.

Pete Turner


Paul Chesley

The Hawaii hot spot, wh
surface expression is mar
today by Mauna Loa, abo
and Kilauea, right, has b
outstandingly vigorous dur
the last few million ye
and continues to remain
Since the early ninetee
century, for example,
average combined annual l
discharge rate of these t
volcanoes has been ab
35 million cubic yar

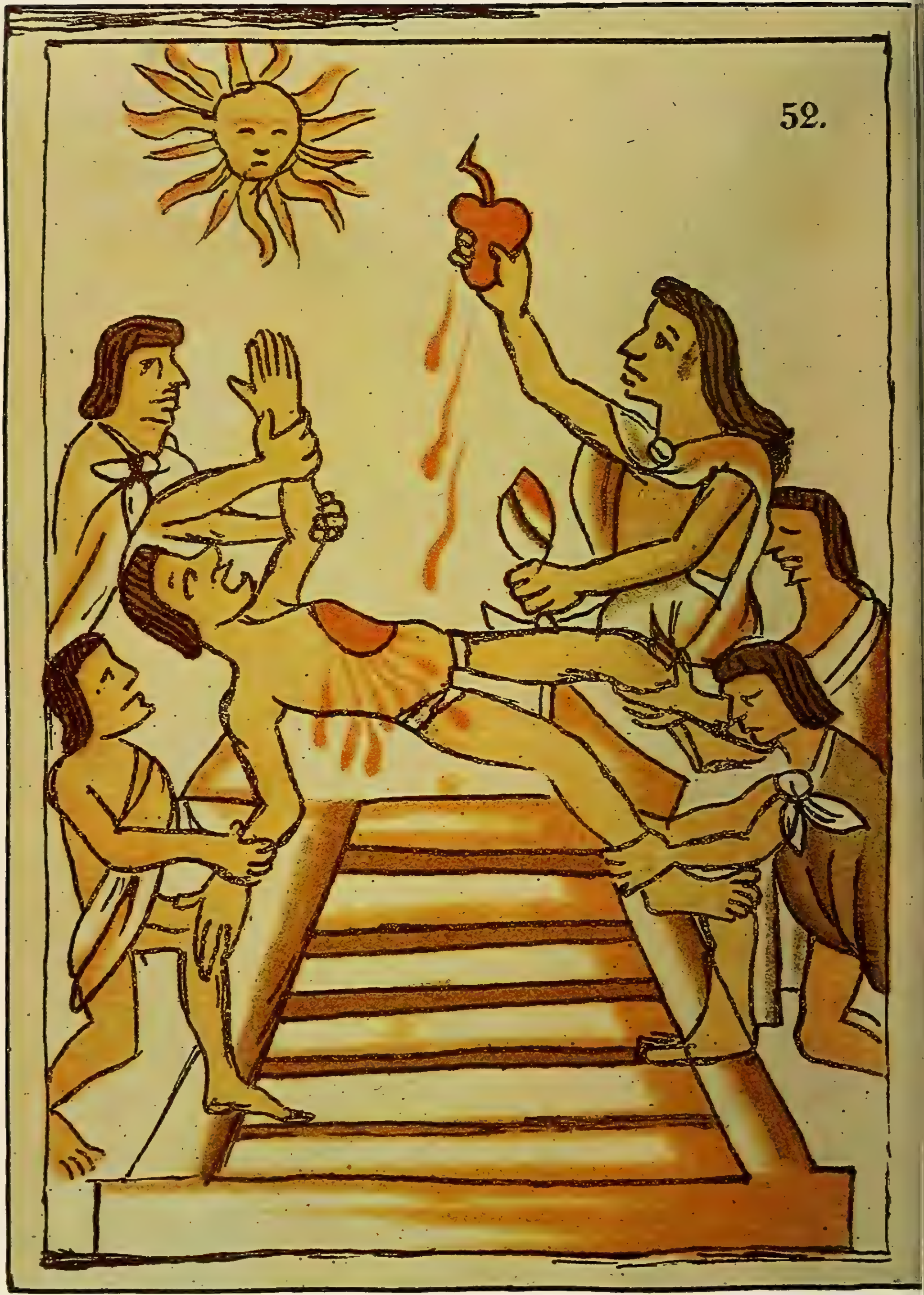
under Yellowstone National Park. That peak discharge rate marked the beginning of strong volcanic activity in the Canary and Cape Verde islands and other hot spots. The increasingly abundant volcanism of the last six million years also affected various other hot spots in addition to Hawaii.

If a seeming correlation between the ups and downs of volcanic activity at different hot spots was unexpected, so was the finding that ash layers in oceanic drill cores revealed discharge highs for the same periods—from twelve to eighteen million years ago and from six million years to the present. Most of this ash does not come from hot spot volcanoes. It comes instead primarily from the notoriously explosive volcanoes situated along such island arcs as the Aleutians, Kuriles, Japan, and the West Indies, where oceanic plates descend into the mantle. The available evidence suggests to me that the world's volcanoes belch simultaneously in a global chorus, a result as surprising as it is unexplained. (By "simultaneously" I am, of course, referring to million-year averages, not annual averages.) Why should hot spot volcanoes and island arc volcanoes vary their output concurrently? One possibility might be that plume convection, responding to episodic instabilities deep in the mantle, accelerates the plates, which in turn cause more island arc volcanism as they are forced into the mantle at a higher rate.

Whatever the cause of hot spots may be, there is still much that we have yet to learn about them. For example, are they truly fixed or do they possibly move with respect to each other? Do they contribute in a manner not now understood to the process of continental drift? More specifically, will the Big Island of Hawaii grow bigger still or be succeeded by an even more spectacular massif of overlapping volcanoes to the southeast? Alternatively, will the volcanic hot spot trails of the Hawaiian chain dwindle once again, as they did after the previous high, twelve to eighteen million years ago?

W. Jason Morgan, who originated the mantle plume idea, has suggested a rise speed of about 2 meters (6½ feet) a year for mantle material in t
ascending plume. At that rate
would take one or two million ye
for an increase or decrease in plu
activity to take effect on the eart
surface after originating at depths
great as the core–mantle bounda
Our volcanic future a few milli
years hence—with all its possi
consequences—may therefore
ready be preordained deep in t
mantle.

John



AMNH

The Enigma of Aztec Sacrifice

y **Michael Harner**

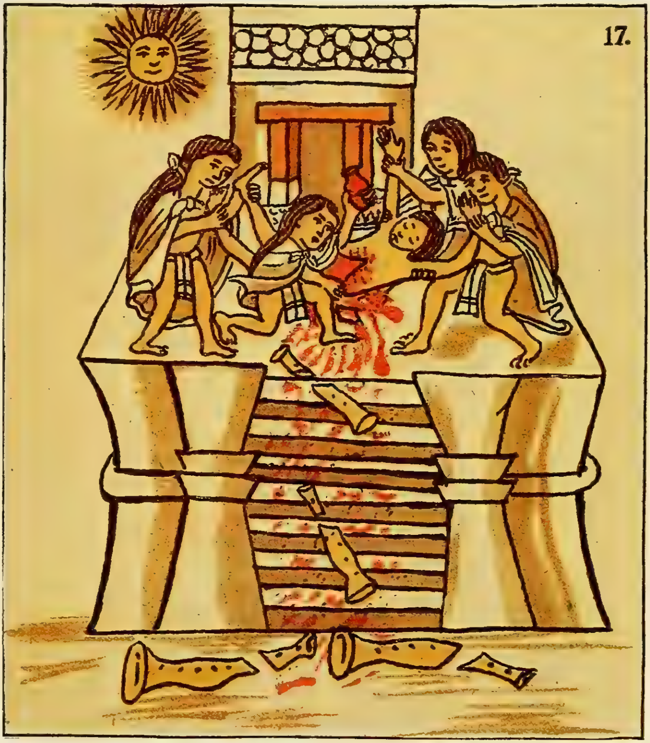
uman sacrifice was meant
appease the appetites
the gods—and of
e Aztecs themselves

On the morning of November 8, 519, a small band of bearded, dirty, hausted Spanish adventurers stood the edge of a great inland lake in ntral Mexico, staring in disbelief at e sight before them. Rising from the nter of the lake was a magnificent land city, shining chalk white in the rly sun. Stretching over the lake ere long causeways teeming with avelers to and from the metropolis, enochtitlán, the capital of the Aztec npire, now known as Mexico City.

The Spaniards, under the command of Hernán Cortés, were fresh om the wars of the Mediterranean nd the conquest of the Caribbean. ough and ruthless men, numbering wer than four hundred, they had fought their way up from the eastern tropical coast of Mexico. Many had been wounded or killed in battles with hostile Indians on the long march. Possibly all would have died but for their minuscule cavalry of fifteen horses—which terrified the Indians, who thought the animals were gods—and the aid of a small army of Indian allies, enemies of the Aztecs.

The panorama of the Aztec citadel across the water seemed to promise the Spaniards the riches that had eluded them all their lives. One of them, Bernal Díaz del Castillo, later wrote: "To many of us it appeared doubtful whether we were asleep or awake . . . never yet did man see, hear, or dream of anything equal to our eyes this day." For the Spaniards, it was a vision of heaven.

Slightly more than a year and half later, in the early summer of 1521, it was a glimpse of hell. Again the



AMNH

wo sixteenth-century drawings from e Florentine Codex *of Bernardino Sahagún. At left, the victim's art is offered to the sun. At ght, priests sacrifice a youth ho had been chosen to personify e Aztec deity Tezcatlipoca for year. Accompanied by a retinue, e future victim often strolled a god on earth, playing one of s clay flutes. When he finally cended to the temple-pyramid atform, he broke his flutes, one one, on the steps. The vast ajority of victims did not enjoy ch presacrificial status.*

The main temple-pyramid at the Maya site of Tikal, Guatemala. The steep steps of Mesoamerican pyramids may have facilitated tumbling down the bodies of victims after sacrifice.

M. P. Kahl, Bruce Coleman, Inc

Spaniards found themselves on the lakeshore, looking toward the great capital. But this time they had just been driven back from the city by the Aztec army. Sixty-two of their companions had been captured, and Cortés and the other survivors helplessly watched a pageant being enacted a mile away across the water on one of the major temple-pyramids of the city. As Bernal Díaz later described it,

> The dismal drum of Huichilobos sounded again, accompanied by conches, horns, and trumpetlike instruments. It was a terrifying sound, and when we looked at the tall *cue* [temple-pyramid] from which it came we saw our comrades who had been captured in Cortés' defeat being dragged up the steps to be sacrificed. When they had hauled them up to a small platform in front of the shrine where they kept their accursed idols we saw them put plumes on the heads of many of them; and then they made them dance with a sort of fan in front of Huichilobos. Then after they had danced the *papas* [Aztec priests] laid them down on their backs on some narrow stones of sacrifice and, cutting open their chests, drew out their palpitating hearts which they offered to the idols before them.

Cortés and his men were the only Europeans to see the human sacrifices of the Aztecs, for the practice ended shortly after the successful Spanish conquest of the Aztec empire. But since the sixteenth century, Aztec sacrifice has persisted in puzzling scholars. No human society known to history approached that of the Aztecs in the quantities of people offered as religious sacrifices: 20,000 a year is a common estimate.

A typical anthropological explanation is that the religion of the Aztecs required human sacrifices; that their gods demanded these extravagant, frequent offerings. This explanation fails to suggest why that particular form of religion should have evolved when and where it did. I suggest that the Aztec sacrifices, and the cultural patterns surrounding them, were a natural result of distinctive ecological circumstances.

Some of the Aztecs' ecological circumstances were common to ancient civilizations in general. Recent theoretical work in anthropology indicates that the rise of early civilizations was a consequence of the pressures that growing populations brought to bear on natural resources. As human populations slowly multiplied, even before the development of plant and animal domestication, they gradually reduced the wild flora and fauna available for food and disrupted the ecological equilibriums of their environments. The earliest strong evidence of humans causing environmental damage was the extinction of
many big game species in Europe
about 10,000 B.C., and in Ameri
north of Mexico by about 9,000 B.
Simultaneously, human populatio
in broad regions of the Old and N
Worlds had to shift increasingly
marine food resources and sma
game hunting. Finally, declini
quantities of wild game and fo
plants made domestication of pla
and animals essential in most regio
of the planet.

In the Old World, domestication
herbivorous mammals, such as catt
sheep, and pigs, proceeded apa
with that of food plants. By ab
7,200 B.C. in the New World, ho
ever, ancient hunters had complete
eliminated herbivores suitable for d
mestication from the area anth
pologists call Mesoamerica, the

on of the future high civilizations of
exico and Guatemala. Only in the
dean region and southern South
nerica did some camel-related spe-
s, especially the llama and the al-
ca, manage to survive hunters' on-
ughts, and thus could be domesti-
ted later, along with another impor-
nt local herbivore, the guinea pig.
Mesoamerica, the guinea pig was
t available, and the Camelidae spe-
s became extinct several thousand
ars before domesticated food pro-
ction had to be seriously under-
ken. Dogs, such as the Mexican
irless, and wildfowl, such as the
key, had to be bred for protein.
e dog, however, was a far from
tisfactory solution because, as a
rnivore, it competed with its
eders for animal protein.

The need for intensified domesti-
ted food production was felt early,
anthropologist Robert Carneiro has
inted out, by growing populations
fertile localities circumscribed by
rain poorly suited to farming. In
ch cases, plants always became do-
esticated, climate and environment
rmitting, but herbivorous mam-
als apparently could not, unless ap-
opriate species existed. In Meso-
nerica, the Valley of Mexico, with
fertile and well-watered bottom-
nds surrounded by mountains, fits
ell Carneiro's environmental
odel. In this confined area, popula-
on was increasing up to the time of
e Spanish conquest, and the supply
wild game was declining. Deer
ere nearly gone from the Valley by
e Aztec period.

The Aztecs responded to their in-
easing problems of food supply by
tensifying agricultural production
ith a variety of ingenious tech-
ques, including the reclamation of
il from marsh and lake bottoms in
e chinampa, or floating garden,
ethod. Unfortunately, their ingenu-
y could not correct their lack of
suitable domesticable herbivore
at could provide animal protein and
its. Hence, the ecological situation
the Aztecs and their Mesoamerican
ighbors was unique among the
orld's major civilizations. I have re-
ntly proposed the theory that large-
ale cannibalism, disguised as sacri-
ce, was the natural consequence of
ese ecological circumstances.

The contrast between Mesoamerica and the Andes, in terms of the existence of domesticated herbivores, was also reflected in the numbers of human victims sacrificed in the two areas. In the huge Andean Inca empire, the other major political entity in the New World at the time of the conquest, annual human sacrifices apparently amounted to a few hundred at most. Among the Aztecs, the numbers were incomparably greater. The commonly mentioned figure of 20,000, however, is unreliable. For example, one sixteenth-century account states that 20,000 were sacrificed yearly in the capital city alone, another reports this as 20,000 infants, and a third claims the same number as being slaughtered throughout the Aztec empire on a single particular day. The most famous specific sacrifice took place in 1487 at the dedication of the main pyramid in Tenochtitlán. Here, too, figures vary: one source states 20,000, another 72,344, and several give 80,400.

In 1946 Sherburne Cook, a demographer specializing in American Indian populations, estimated an overall annual mean of 15,000 victims in a central Mexican population reckoned at two million. Later, however, he and his colleague Woodrow Borah revised his estimate of the total central Mexican population upward to 25 million. Recently, Borah, possibly the leading authority on the demography of Mexico at the time of the conquest, has also revised the estimated number of persons sacrificed in central Mexico in the fifteenth century to 250,000 per year, equivalent to one percent of the total population. According to Borah, this figure is consistent with the sacrifice of an estimated 1,000 to 3,000 persons yearly at the largest of the thousands of temples scattered throughout the Aztec Triple Alliance. The numbers, of course, were fewer at the lesser temples, and may have shaded down to zero at the smallest.

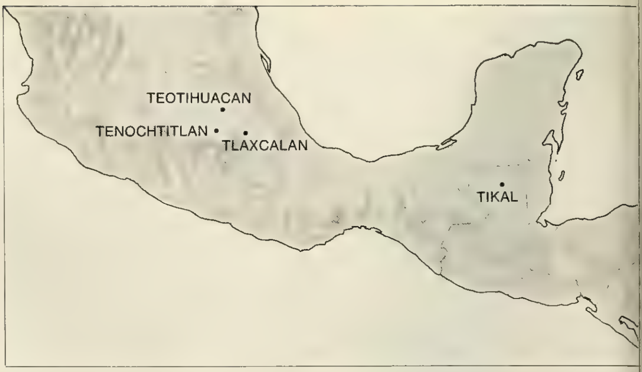
These enormous numbers call for consideration of what the Aztecs did with the bodies after the sacrifices. Evidence of Aztec cannibalism has been largely ignored or consciously or unconsciously covered up. For example, the major twentieth-century books on the Aztecs barely mention it; others bypass the subject completely. Probably some modern Mexicans and anthropologists have been embarrassed by the topic: the former partly for nationalistic reasons; the latter partly out of a desire to portray native peoples in the best possible light. Ironically, both these attitudes may represent European ethnocentrism regarding cannibalism—a viewpoint to be expected from a culture that has had relatively abundant livestock for meat and milk.

A search of the sixteenth-century literature, however, leaves no doubt as to the prevalence of cannibalism among the central Mexicans. The Spanish conquistadores wrote amply about it, as did several Spanish priests who engaged in ethnological research on Aztec culture shortly after the conquest. Among the latter, Bernardino de Sahagún is of particular interest because his informants were former Aztec nobles, who supplied dictated or written information in the Aztec language, Nahuatl.

According to these early accounts, some sacrificial victims were not eaten, such as children offered by drowning to the rain god, Tlaloc, or persons suffering skin diseases. But the overwhelming majority of the sacrificed captives apparently were consumed. A principal—and sometimes only—objective of Aztec war expeditions was to capture prisoners for sacrifice. While some might be sacrificed and eaten on the field of battle, most were taken to home communities or to the capital, where they were kept in wooden cages to be fattened until sacrificed by the priests at the temple-pyramids. Most of the sacrifices involved tearing out the heart, offering it to the sun and, with some blood, also to the idols. The corpse was then tumbled down the steps of the pyramid and carried off to be butchered. The head went on the local skull rack, displayed in central plazas alongside the temple-pyramids. At least three of the limbs were the property of the captor if he had seized the prisoner without assistance in battle. Later, at a feast given at the captor's quarters, the central dish was a stew of tomatoes, peppers, and the limbs of his victim. The remaining torso, in Tenochtitlán at least, went to the royal zoo where it was used to feed carnivorous mammals, birds, and snakes.

Recent archeological research

lends support to conquistadores' and informants' vivid and detailed accounts of Aztec cannibalism. Mexican archeologists excavating at an Aztec sacrificial site in the Tlatelolco section of Mexico City between 1960 and 1969 uncovered headless human rib cages completely lacking the limb bones. Associated with these remains were some razorlike obsidian blades, which the archeologists believe were used in the butchering. Nearby they also discovered piles of human skulls, which apparently had been broken open to obtain the brains, possibly a choice delicacy reserved for the priesthood, and to mount the skulls on a ceremonial rack.



Through cannibalism, the Aztecs appear to have been attempting to reduce very particular nutritional deficiencies. Under the conditions of high population pressure and class stratification that characterized the Aztec state, commoners or lower-class persons rarely had the opportunity to eat any game, even the domesticated turkey, except on great occasions. They often had to content themselves with such creatures as worms and snakes and an edible lake-surface scum called "stone dung," which may have been algae fostered by pollution from Tenochtitlán. Preliminary research seems to indicate that although fish and waterfowl were taken from the lakes, most of the Aztec poor did not have significant access to this protein source and were forced to be near-vegetarians, subsisting mainly on domesticated plant foods such as maize and beans.

The commoners theoretically could get the eight essential amino acids necessary for building body tissues from maize and beans. (A combination of the two foods complement each other in their essential amino acid components.) However, recent nutritional research indicates that in order to assure that their bodies would use the eight essential amino acids to rebuild body tissues, and not simply siphon off the dietary protein as energy, the Aztec commoners would have had to consume large quantities of maize and beans simultaneously or nearly simultaneously year-round. But crop failures and famines were common. According to Durán, a sixteenth-century chronicler, poor people often could not obtain maize and beans in the same season, and hence could not rely upon these plants as a source of the essential amino acids. How did the Aztecs know they needed the essential amino acids? Like other organisms perfected under natural selection, the human body is a homeostatic system that, under conditions of nutritional stress, tends to seek out the dietary elements in which it is deficient. Without this innate capacity, living organisms could not survive.

Another Aztec dietary problem was the paucity of fats, which were so scarce in central Mexico that the Spaniards resorted to boiling down the bodies of Indians killed in battle in order to obtain fat for dressing wounds and tallow for caulking boats. While the exact amount of fatty acids required by the human body remains a subject of uncertainty among nutritionists, they agree that fats, due to their slower rate of metabolism, provide a longer-lasting energy source than carbohydrates. Fatty meat, by providing not only fat, which the body will use as energy, but also essential proteins, assures the utilization of the essential amino acids for tissue building. Interestingly, prisoners confined by the Aztecs in wooden cages prior to sacrifice could be fed purely on carbohydrates to build up fat.

In contrast to the commoners, the Aztec elite normally had a diet enriched by wild game imported from the far reaches of the empire where species had not been so depleted. But even nobles could suffer from famines and sometimes had to sell their children into slavery in order to survive. Not surprisingly, the Aztec eli
apparently reserved for themselve
the right to eat human flesh, and co
veniently, times of famine meant th
the gods demanded appeaseme
through many human sacrifices.

At first glance, this prohibitio
against commoners eating huma
flesh casts doubt on cannibalism's p
tential to mobilize the masses
Aztec society to engage in wars f
prisoners. Actually, the prohibitio
was, if anything, a goad to the low
class to participate in these wars sin
those who single-handedly took ca
tives several times gained the right
eat human flesh. Successful warrio
became members of the Aztec eli
and their descendants shared the
privileges. Through the reward
flesh-eating rights to the group mo
in need of them, the Aztec rulers a
sured themselves an aggressive w
machine and were able to motiva
the bulk of the population, the poo
to contribute to state and upper-cla
maintenance through active partic
pation in offensive military oper
tions. Underlying the war machine
victories, and the resultant sacrifice
were the ecological extremities of t
Valley of Mexico.

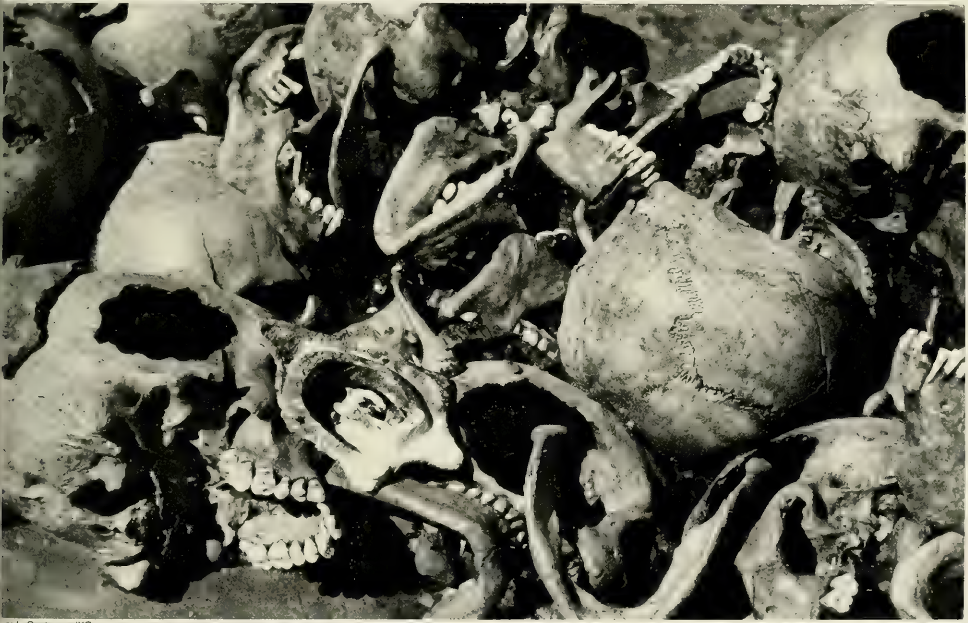
With an understanding of the in
portance of cannibalism in Aztec cu
ture, and of the ecological reasons f
its existence, some of the Aztec
more distinctive institutions begin
make anthropological sense. For e
ample, the old question of wheth
the Aztecs' political structure was
was not an "empire" can be reexar
ined. One part of this problem is th
the Aztecs frequently withdrew fro
conquered territory without establis

g administrative centers or garri-
ns. This "failure" to consolidate
nquest in the Old World fashion
zzled Cortés, who asked Mocte-
ma to explain why he allowed the
rrounded Tlaxcalans to maintain
eir independence. Moctezuma
portedly replied that his people
uld thus obtain captives for sacri-
e. Since the Aztecs did not nor-
ally eat people of their own polity,
hich would have been socially and
litically disruptive, they needed
arby "enemy" populations on
hom they could prey for captives.
is behavior makes sense in terms
Aztec cannibalism: from the Aztec
int of view, the Tlaxcalan state was
eserved as a stockyard. The Aztecs
ere unique among the world's states
having a cannibal empire. Under-
andably, they did not conform to
ld World concepts of empire, based
economies with domesticated her-
vores providing meat or milk.

The ecological situation of the
ztecs was probably an extreme case
problems general to the high popu-
tion pressure societies of Meso-
nerica. Cannibalism encouraged
e definition of the gods as eaters of
man flesh and led almost inevitably
emphasis on fierce, ravenous, and carnivorous deities, such as the jaguar and the serpent, which are characteristic of Mesoamerican pantheons. Pre-Columbian populations could, in turn, rationalize the more grisly aspects of large-scale cannibalism as consequences of the gods' demands. Mesoamerican cannibalism, disguised as propitiation of the gods, bequeathed to the world some of its most distinctive art and architecture. The temple-pyramids of the Maya and the Toltecs, and of the pre-Aztec site at Teotihuacán in the valley of Mexico, resemble those of the Aztecs in appearance and probably had similar uses. Even small touches, such as the steepness of the steps on pyramids in Aztec and other Mesoamerican ruins, become understandable given the need for efficiently tumbling the bodies from the sacrificial altars to the multitudes below. Perhaps those prehistoric scenes were not too dissimilar from that which Bernal Díaz described when his companions were sacrificed before his eyes in Tenochtitlán:

> Then they kicked the bodies down the steps, and the Indian butchers who were waiting below cut off their arms and legs and flayed their faces, which they afterwards prepared like glove leather, with their beards on, and kept for their drunken festivals. Then they ate their flesh with a sauce of peppers and tomatoes.

Gruesome as these practices may seem, an ecological perspective and population pressure theory render the Aztec emphasis on human sacrifice acceptable as a natural and rational response to the material conditions of their existence. In *Tristes Tropiques,* the French anthropologist Claude Levi-Strauss described the Aztecs as suffering from "a maniacal obsession with blood and torture." A materialist ecological approach reveals the Aztecs to be neither irrational nor mentally ill, but merely human beings who, faced with unusual survival problems, responded with unusual behavior. ☐



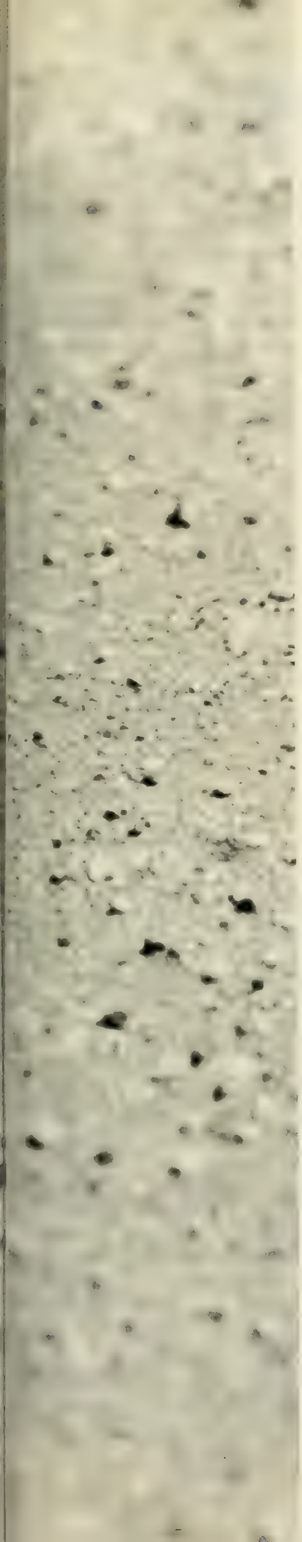
Skulls of sacrificial victims at the Aztec site of Tlatelolco, Mexico City. Mexican archeologists believe that the holes were made both to remove the brains and to mount the skulls on a rack.

ardo Contreras, IXO

Vest-pocket Turtle

Text and photographs by Jim Cooper

Confined to a few midwestern localities, the Illinois mud turtle faces a demanding environment and extinction



Recently emerged from hibernation, an Illinois mud turtle moves slowly over a barren stretch of Big Sand Mound in eastern Iowa, possibly in search of a pond in which to begin feeding.

The empty shell lay in the scrubby vegetation beneath a canopy of cedar boughs. Close examination revealed it was the shell of an Illinois mud turtle, but the surroundings offered no clue to what caused the turtle's demise or to how the shell came to be atop this sand dune. I had come to Big Sand Mound in eastern Iowa, to study this turtle, so I noted my exact location and a few details of the find in my journal and dropped the fist-sized shell into my field bag.

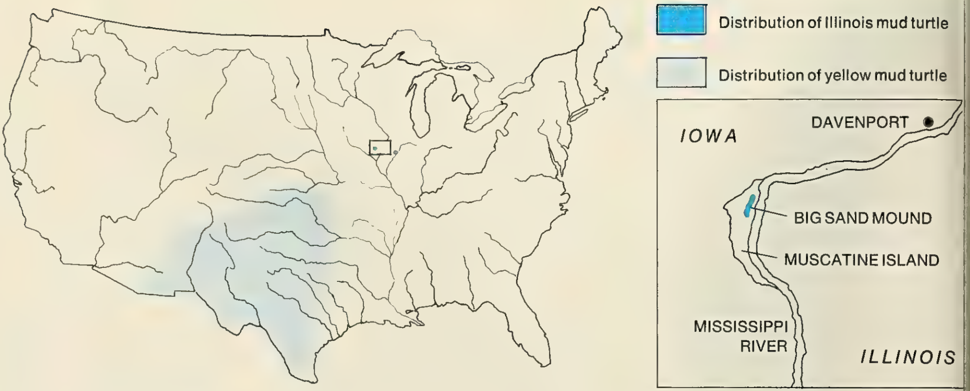
This was not my first encounter with the Illinois mud turtle under what seemed, to my untrained eyes, to be unusual circumstances. Once, while rounding a bend in a tractor road, I had come upon a dead female, her shell crushed by the recent passage of a vehicle. The nearest body of water was almost a half mile away, and the animal appeared to have been going in the opposite direction.

Such incidents had sparked my interest in the Illinois mud turtle, a plain creature whose nearest relative has a range with a center almost a thousand miles south in the arid southwestern United States. What I learned in two years of study was the probable role of a rigorous and changing environment in the evolution of a geographically isolated turtle.

Kinosternon flavescens spooneri is not nearly as imposing a creature as its scientific name. It is rarely more than five inches long, and its domed shell is a dingy olive or brown with no ornamentation. The turtle's distinguishing features are its bright yellow chin, a plastron with two well-developed transverse hinges, and a disagreeable odor that issues from musk glands when the animal senses a threat.

Despite its generally unremarkable physical appearance, the Illinois mud turtle does have several characteristics to attract the student of natural history: its distribution is sharply limited, the area it inhabits is a remnant prairie, and it appears to have adaptations to a drier environment than that in which it is found. In addition, the Illinois mud turtle is a member of a largely unstudied group of turtles—the mud and musk turtle family.

In eastern Muscatine County, Iowa, bordered by the Mississippi River, is Big Sand Mound. Occupying about 1,500 acres, this formation is one of the outstanding features of Muscatine Island, a vaguely defined region delineated by an old channel of the river. From the highway that skirts its western edge, Big Sand Mound appears as a large hump, roughly two miles long, rising fifty to sixty feet above the river flood plain. The mound had its origin in the windblown sediments of a prehistoric lake, located about twenty miles to the west, and its ecological characteristics are anomalous to the sur-


🟦 Distribution of Illinois mud turtle
▢ Distribution of yellow mud turtle
IOWA
DAVENPORT
BIG SAND MOUND
MUSCATINE ISLAND
MISSISSIPPI RIVER
ILLINOIS

rounding countryside. Topographically, it is similar to Nebraska's Sand Hills or the dune country around Lake Michigan.

Parts of the mound's slopes are covered with prairie grasses and heavily forested in oak, hickory, red cedar, and ash, while the top is mostly cultivated. The mound's eastern edge is a sparsely vegetated region of shifting sands—small dunes that form and re-form, sometimes burying tree trunks ten to twenty feet up. However, three distinct types of aquatic habitats occur there. A large, shallow oxbow lake winds around the northern and eastern edges of the mound. This lake, almost completely ringed in willow growth, is separated from the Mississippi by a large dike. Several permanent ponds lie just south of the oxbow, while in the surrounding sandy lowlands, scattered temporary ponds hold water usually until midsummer. These three habitats and the adjacent sands support the largest known population of Illinois mud turtles. Western hognose snakes, ornate box turtles, and other relict Plains animals also inhabit the dunes, and scattered among the grasses are prickly pear cacti.

April is the month of awakening for the hibernating denizens of the mound. Dazed and sluggish, they emerge to begin another year. Among them is the Illinois mud turtle.

For several weeks after emerging from hibernation, mud turtles rarely enter water. Temperatures in the ponds are usually too low to permit activity and so the turtles undertake overland journeys of considerable length. These apparently random movements may be related to the turtles seeking water warm enough to begin activity.

As seasonal temperatures moderate, the turtles begin entering water in search of food. In early May, they sometimes move into shallow water in the early morning and remain still for several hours before advancing into deeper water to feed. Such activity is a form of temperature regulation: the sun-warmed shallows elevate the turtle's body temperature from 18° to 32° C, preparing it for activity in the cooler depths. Also, such behavior may serve to concentrate the turtles in groups, facilitating courtship and mating, both of which occur in water. By mid-May, the turtles begin to bask. Small groups of isolated individuals rest watchfully on floating debris or exposed shorelines while the sun is high.

Once the waters have warmed enough to permit extended immersion, mud turtles are rarely seen on land unless they are venturing between ponds. Terrestrial excursions are usually restricted to the morning or late evening.

Rising temperatures in June bring further alterations to the Illinois mud turtle's daily routine. Basking now shifts from exposed to shaded sites and the turtles begin spending less time at the surface of the water. Some turtles, instead of basking, just float motionless at the surface, submerging to the depths at the slightest disturbance.

In the water, mud turtles fora
over the bottom in search of fis
crustaceans, and insects. Aqua
vegetation and decayed animal mat
are eaten, but aquatic beetles, dra
onfly larvae, and other larval inse
are the major items in their diet.
early summer, mud turtles feed hea
ily on the fairy shrimp that teem
the warm, shallow waters of seaso
ponds. As the summer progress
they shift to foraging in the mud
ooze that bottoms the larger bodies
water. A favored source of inse
prey is the flooded woodland that s
rounds a large lake after extended p
riods of heavy rain.

Middle to late June is the beginni
of Illinois mud turtle nesting on B
Sand Mound. Shallow excavations
the sand, some surrounded by t
crushed and dried remnants of tur
eggs left behind by marauding skun
and raccoons, are visual evidence th
nesting has begun.

Predation pressure is highest du
ing a period of several days followi
egg laying, because the femal
scent is still strong and the disturb
sand marks the nest site. Female m
turtles construct more elaborate ne
than many other species, sometim
even constructing false nests that
identical in configuration to the r
ones. The female may remain in
false nest for several days bef
moving to a new site. This behav
is possibly a mechanism to thw
predators by increasing the effort
volved in dining on turtle eggs.

The female mud turtle seeks a sp
among scattered clumps of gra

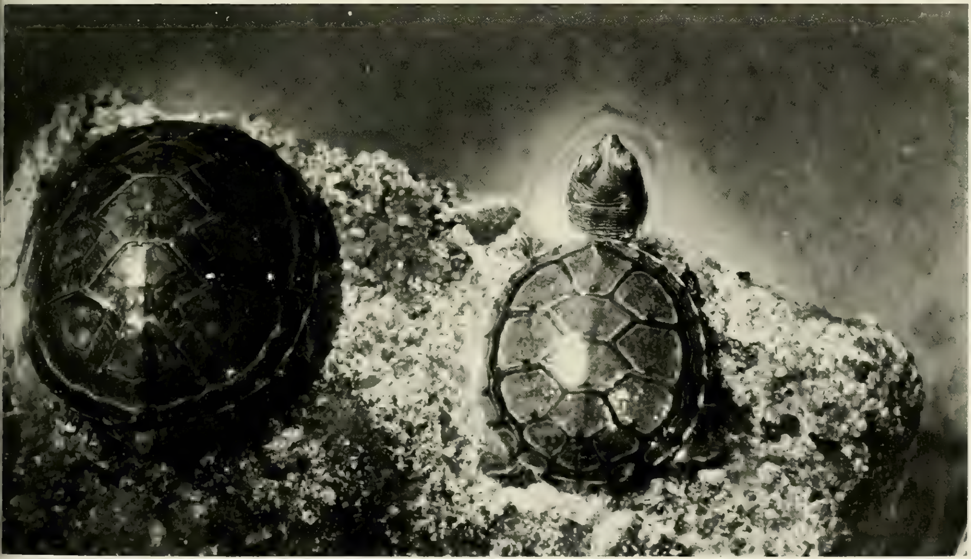
ually on an east-facing slope and ways within a few hundred feet of ater. She begins to burrow with her relegs, vigorously tossing the sand hind her. When only the rear marn of her shell is exposed, the turtle verses herself in the burrow. She en pushes sand upward, covering e entrance above her. The female ys from two to six hard-shelled, eltical eggs, then uncovers herself d replaces the sand. The characristic of enclosing herself within the st distinguishes the Illinois mud rtle from the majority of turtle spees. Most turtles simply scoop a deession in the sand with their hind gs, deposit the eggs, and scrape bris and earth over them before rerning to water.

How long a female mud turtle reains in the nest is as yet unknown. early July, I came across a circle moist sand about six inches in dineter; its moistness indicated it was freshly dug nest. Digging into it, I tracted a female mud turtle, blinkg at the brilliance of the sunlight. eneath her in the excavation were ur still moist eggs. I returned the rtle to her nest, covered it, and left. eturning an hour later, I found the rface of the nest as I had left it. But amination disclosed that the female d departed. How long she would ve remained had I not disturbed her, I cannot guess. This is not to imply that the turtle was tending the nest; more likely her actions were related to temperature regulation. In July, surface sand temperatures can become inhospitably high. Mud turtles traveling overland at this time sometimes deal with the extreme temperature by spending the hottest part of the day in a burrow, emerging at sunset to resume activity. Such was probably the case with this female.

Young Illinois mud turtles hatch in September and are approximately the diameter of a quarter. They resemble adults in marking and coloration except for the presence of a series of black spots on the upper shell and an irregular black blotch on the underside. Attached to the lower shell is the bright yellow yolk sac that provides nourishment to the young turtle through the first weeks of its life. I was not able to determine the time of emergence from the nest, but data from other mud turtle species suggest that the young might remain in the nest after hatching, live off the yolk sac, then hibernate until the following spring.

One might expect that exposure to Iowa's withering July and August heat would cause the mud turtles to become even less terrestrial than they are in June. Instead, a reversal in behavior takes place at this time. As temperatures soar into the nineties, basking in water ceases and mud turtles begin to appear more frequently on land, sometimes even at midday. By late July the turtles begin leaving the ponds in the early morning and moving into the sand where they bury themselves during the heat of the day, emerging at night to return to the ponds.

This behavior appears to be an adaptation to a grassland environment of high summer temperature and an intermittent water supply. As the smaller ponds begin to dry up, daytime water temperatures reach potentially lethal levels, forcing the turtles out. In the moist sand beneath the vegetated slopes, temperatures remain tolerable. While pond and surface temperatures exceed 40°C, subsurface sand temperatures remain a tolerable 25° to 27°. The turtles move back and forth at first, burying themselves in the daytime and emerging to



Young turtles bask in the rays of the midday sun. At this stage of their lives, they are vulnerable to such predators as skunks and raccoons.

return to the ponds late at night. This appears to be a relict behavioral pattern. Alterations of the aquatic habitats on the mound have resulted in some areas that are deep enough and large enough to remain habitable throughout the hot days of summer.

Such behavior increases into early August when activity abruptly ceases. Suddenly the sand surface is devoid of mud turtles, as are the ponds. Other turtle species continue their activities, sometimes even basking; but at this time, no amount of trapping, netting, or tramping through the sand produces even a glimpse of an Illinois mud turtle.

August is the month of aestivation for Illinois mud turtles on Big Sand Mound. A behavioral mechanism that aids certain animals in surviving periods of extreme heat, aestivation is particularly important to animals that inhabit arid and desert regions. As temperatures rise to unfavorable levels, the animal selects a cool place, usually beneath the soil surface or in the damp ooze at the bottom of a drying pond. Here it remains in a state of dormancy until more tolerable conditions prevail.

So, after a period of movement to and from the ponds, the mud turtles simply settle into a sandy burrow near the overheated waters. The water table at the mound is very high; and the root systems of the plant cover help to retain some of the thirty-three inches of annual precipitation. The ponds along the eastern edge of the mound are not much higher than the Mississippi River. Some of these ponds, where most Illinois mud turtle activity occurs, actually rise and fall with the river. On the higher slopes, where burrowing takes place, moist sand is seldom more than a foot beneath the surface. In the cool sand, the turtles await the return of more moderate weather.

The turtles sometimes go directly from aestivation to hibernation, remaining inactive from August until the following spring. During such years the Illinois mud turtle might have the shortest annual activity period of any turtle—fewer than one hundred days.

Much Illinois mud turtle behavior centers around its thermoregulatory demands. A cold-blooded vertebrate inhabiting areas of temperature extremes beyond those it can physiologically tolerate must evolve behavioral adaptations to regulate its temperature.

During late Tertiary and Pleistocene times, the Southern Great Plains Corridor, a broad belt of land extending from southwestern North America northward along the eastern slope of the Rocky Mountains into Canada, played an important role in reptile dispersal. From population centers in the Southwest and the Mexico Plateau, subtropical species advanced northward with favorable climatic changes and retreated south when adverse conditions prevailed. Among the reptiles that used this dispersal route were the ornate box turtle, western hognose snake, and the yellow mud turtle (*Kinosternon flavescens*). Responding to increasing aridity in the Southwest and Great Plains, the yellow mud turtle evolved specialized traits. Conditions demanded that the turtles move about in the early spring to find water warm enough to begin such activities as feeding and mating. In summer, it became necessary to locate waters cool enough to continue such activities. Predominantly aquatic, the turtles still had to develop a tolerance for extended terrestrial activity. When no suitable aquatic habitat was available, as during late-summer drought, aestivation was necessary to enable the turtle to survive until more tolerable conditions returned, while hibernation provided a means of withstanding the bitter prairie winters. In areas where environmental conditions moderated, these extreme behaviors lingered on as relicts, reminders of the species' ancestry.

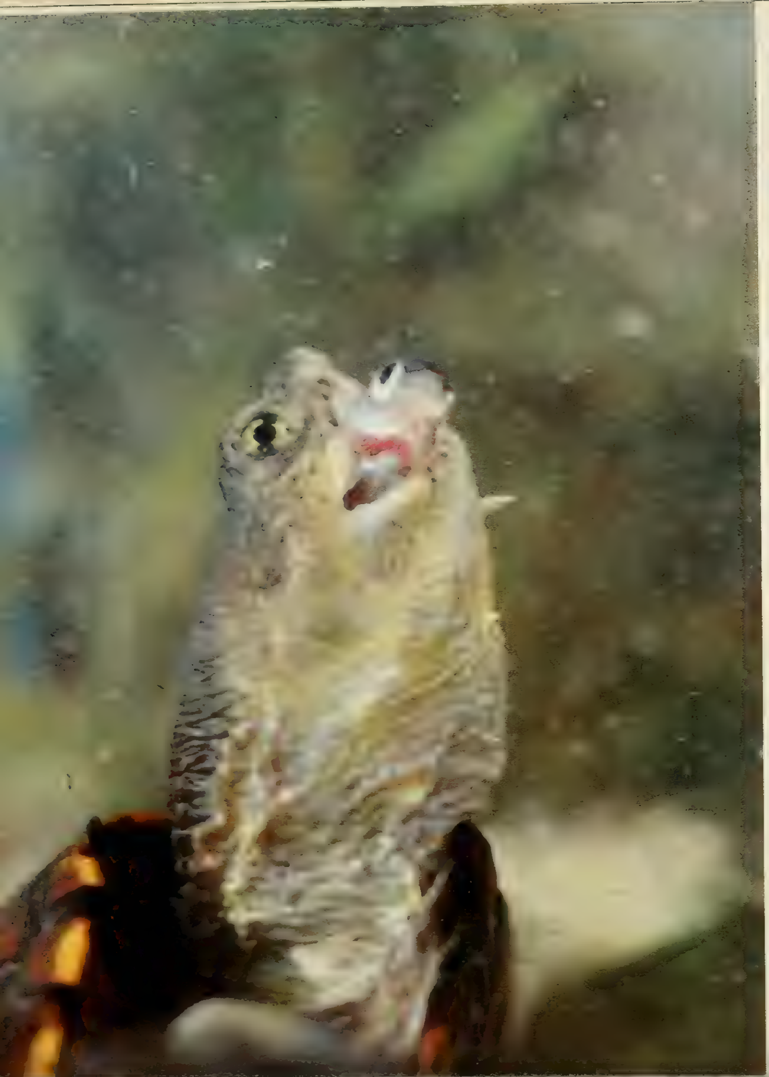
Today, three subspecies of the yellow mud turtle are recognized. *Kinosternon flavescens flavescens* occurs widely throughout the southwestern United States, ranging from Nebraska to Mexico. Adapted to the arid conditions of the Plains, it can be found in temporary ponds and potholes, and more recently, in cattle troughs. *K. f. stejnegeri*, the Mexican yellow mud turtle, is found in Mexico. The Illinois mud turtle has the most limited distribution. It now occurs in only a few localities in eastern Iowa and Illinois—areas characterized as remnant sand prairie.

Illinois mud turtles prey
aquatic organisms, ranging fr
small fish to fairy shrimp, o
scavenge for decaying fish fle
This adult is feeding on a you
bluegill it has just captur

This pattern of distribution suggests that the ancestral yellow m turtle was once found over a larg area of North America. Changi conditions, brought about by the a vance and retreat of glacial ice ar more recently, by the arrival of ma might have resulted in the turtle's d appearance over some of that are with only a few populations remai ing in ecological pockets that retain some favorable characteristics. Su separation would eventually lead the formation of subspecies and pro ably accounts for the presence of t Illinois mud turtle.

As with any animal that occupi an extremely limited range, the Il nois mud turtle's future is far fro assured. The dwindling of the prai has resulted in the loss of much pote tial mud turtle habitat. Man's acti ties, such as draining sloughs and po holes and cultivating grasslan have also aggravated conditions. I deed the Illinois mud turtle seems be declining in numbers. Populatio have decreased in Illinois in rece years and disappeared in Missou where the subspecies formerly e isted; in Iowa the turtle is almost e clusively confined to the tiny area Muscatine Island, near an area rapid industrialization. Such popul tion declines may be a result of nat ral trends or of the encroachments man; most likely they are a combin tion of the two. Whatever the caus it is unlikely that the trend will reversed.

Eggshells scattered around a
Illinois mud turtle's nest a
evidence of a raid by a skunk
raccoon. Nest mortality is highe
during the period when the female
scent is still strong on the ne



Drums of Calanda

Text and photographs by Tor Eigeland

Each Good Friday this sleepy town awakens with a sudden clamor before resuming its repose for another year

As the church bells struck noon on Good Friday, the best drumsticks of the best drummer hit the best drum in Calanda. Gently but firmly, an intricate rhythm began to shape patterns of beats and syncopated, staccato sounds. The thousands of other drums in the little town were silent. Tomás Gascón, tall, dark, and strong, drummed on. An enchanted anticipation filled the air. Suddenly, Tomás Gascón stopped and, in the dead silence that followed, half smiled.

Then all hell broke loose. Twelve hundred small sticks struck six hundred small drums, and four hundred big sticks pounded upon four hundred *bombos*—large bass drums. The noise hit one in the guts like the fist of a heavyweight boxer. It was earsplitting, shattering, frightening. People who do not venture into Calanda on this day claim that the drums can be heard seven miles away.

At any other time of year Calanda is a quiet town of some 4,000 souls and many animals located in the middle of farming country in lower Aragón—about 200 miles east and slightly to the north of Madrid. To outsiders, Calanda—with its ageless, clustered houses—is unremarkable, typical of thousands of other towns that dot the Spanish countryside. To the townspeople, however, it is remarkable not only for its annual drumming ceremony but also as the birthplace of filmmaker Luis Buñuel.

Neither rich nor poor, the town is very old—nobody knows for certain how old. Its narrow streets are lined with two- or three-story, ocher-gray buildings, whose ground floors hold several bars and many small and simple shops. The town's heart, the Plaza de la Iglesia, is dominated by a cathedral. Anyone who is not at home or out of town can generally be found in the plaza. Even so, the hot midday sun usually empties it of people until dusk, when it fills with groups talking and strolling. But at noon on Good Friday, it churns with an expectant crowd.

A lull follows the first frantic drumming while religious processions form. A statue of Jesus bearing his cross is carried out of the cathedral on a float. Statues of the Virgin Mary and other religious figures follow. "Roman" soldiers, looking as if they had always been here, accompany the floats, as do long rows of drummers in purple tunics and pointed Ku Klux Klan-like peaked hoods. The drums return to a steady beat: "Da-rrramm–da-rrramm–da-rrramm, da-rrrammarrrarrammarra–rrramm." Jesus and the Virgin Mary rock back and forth as the people carrying

the floats follow the rhythm of the drums. Solemnly, the procession winds its way through the streets of Calanda, then returns to the cathedral for the Mass.

A free-for-all of drumming follows the Mass. Bands of from ten to thirty drummers swarm through the town, stopping outside the homes of friends and families, where according to tradition, they are served cookies and wine. Other drummers stay in the plaza—alone or in constantly moving groups, fragmenting and re-forming with new people. When overcome by thirst or fatigue or both, the drummers stroll into one of the bars for wine or beer. Although the drinking is constant, there is no drunkenness; the Calandinos imbibe just enough to keep going. And with the clamoring of the drums, there is no room for shouting or yelling or even for the crying of babies. The few tourists present are treated with friendly indifference. The big occasion to them is an enormous drum that they can bang on.

After a few hours, the relentless pounding on the *bombos* begins to break the skin of the drummers' hands and blood colors the big drums. Some seem not to mind or notice; others put on gloves when the pain becomes too great. Perhaps the flowing blood represents a religious purification.

In the late afternoon, another mass followed by a rest period provides a hiatus from the din. But at about 10:00 P.M. the drumming starts up again. It does not stop until 2:00 P.M. the next day. During this sixteen-hour period, the constant, thunderous drumming becomes hypnotic, the drummers hypnotized. Religious fervor, country wine, and more blood on the *bombos* are some of ingredients of this annual scene. During the night, pe have been known to stroll straight into the countrys oblivious, drumming, and muttering to themselves.

The year that I observed the drumming ritual, a blo woman in a light blue blouse provided a stark, somew Buñuelesque sight as her strong right arm slammed drumstick on the pale tan *bombo*-skin. Caught up in steady surge of the rhythm, she was indifferent to lacerations on her hand and fingers caused by hitting edge of the big drum; the patch of red blood slo spreading over it, provided a startling contrast in col The woman later put on a glove but kept on drumm till the end.

The bars stayed busy and were open all night. In relative quiet behind the closed doors, I asked sev people about the origin of this curious custom. To Gascón's reply was typical: "I've played since my mo carried me in her arms. And my father played since was a baby. I think we have always played the dr here." A priest said that drums were probably first he in Calanda in 1643 when Roman soldiers appeared present a full coat of armor from the Roman authori to a Calanda notable by the name of Miguel Pellicer.

At 2:00 P.M. on Saturday, the drumming stops al once after a brief ceremony. The silence is almos deafening as the beginning of the drumming on G Friday. Half-stunned, the people stroll off alone or in t and threes. Half an hour later Calanda is just a quiet, d little town again.

he Pit and the Antlion

Howard Topoff

ant that stumbles into this
is on a one-way slide to
waiting jaws of death

n insect larva is a transient con-
r inside of which are developing
e important evolutionary adapta-
of the adult organism. But a
can lead an existence every bit
ascinating and complex as the
t. Even without such structures as
s and copulatory organs, an in-
larva is a mature animal in many
ects, often possessing specialized
tations that endow it with a life-
markedly different from its adult
nts. One of the best examples of
a developmental dichotomy is
antlion, which together with the
onflies, owlflies, and lacewings
ngs to the order Neuroptera.

he adult antlion, with its long,
der body and delicate out-
ched wings, resembles a dam-
y. The larva, by contrast, is a
hly wedge-shaped creature that
ds almost all of its time hidden
ath the soil. Because their spe-
zed structural and behavioral ad-
tions make them efficient and dra-
ic predators, antlion larvae are
ng the few nonpest insects to
generated more behavioral stud-
han the adult forms.

hat has made larval antlions a fa-
te study subject for more than 200
s is their behavior of constructing
nnel-shaped pit in dry sand and
ing upon small terrestrial animals that accidentally fall into it. As its common name implies, the antlion larva feeds predominantly upon the many species of ants that forage in its environment, not because of any unique feeding specialization, but simply because ants are usually the most abundant wingless arthropods wherever antlions are found. The larva will, in fact, just as readily consume a wide variety of arthropods, including spiders, sowbugs, caterpillars, and beetles.

antlion waits for prey at
bottom of its pit. A victim
falls into the trap
ared in a death grip
he antlion's mandibles.

off

An antlion excavates its pit by moving backward in a circle, using its oval-shaped abdomen as a plow and its flat head as a shovel for flicking sand upward. When the pit is completed, the larva lies motionless on the bottom, concealed beneath the sand, with only its long, piercing mandibles exposed. When a foraging ant or other suitably small prey accidentally steps over the rim of a pit, the sand particles making up that portion of the sloping wall roll downward, carrying the victim to the skewerlike mandibles of the waiting antlion.

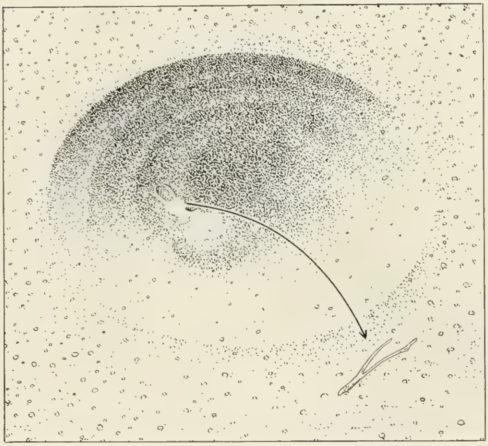
Frequently, the antlion does not successfully impale its prey on the first attempt, and the prey tries to escape up the angled wall and out of the pit. But as the potential victim scurries upward, it dislodges the tiny dry sand particles beneath it and finds itself on a treadmill—moving its legs as fast as it can but making no upward progress. To make matters worse for the prey, the antlion responds to the mechanical stimulation of the miniature sand avalanche resulting from this activity by flicking its head upward and showering the prey with sand. As this storm of loose sand falls on the slope of the pit it speeds up the treadmill effect. The prey loses ground and eventually tumbles back toward the waiting antlion.

As soon as it has trapped the prey with its mandibles, the antlion moves backward, dragging the victim deeper into the sand and sucking out its protein-rich body fluids. Holding on to its prey is no simple task, especially when an antlion snares an animal considerably larger than itself. Here it is aided by a morphological adaptation consisting of numerous hair tufts that project anteriorly. Anyone who has ever used a toggle bolt will appreciate how these hairs function. When the antlion moves backward, the hairs bend and offer little resistance. But when a struggling prey organism attempts to pull the antlion forward, the hairs flare outward and anchor into the substrate.

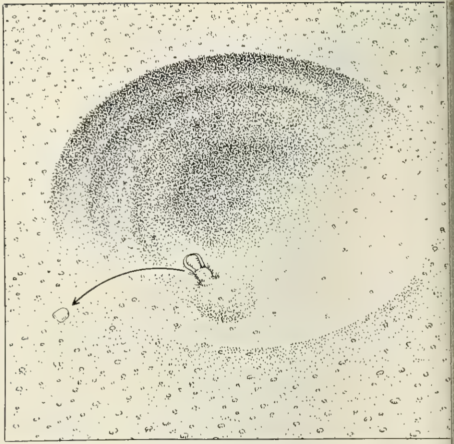
For several springs, I have led an animal behavior class at The American Museum of Natural History's Southwestern Research Station in Arizona. We worked exclusively with *Myrmeleon immaculatus*, a species extremely abundant in the fine silt deposited along the banks of a creek near the research station. Many of our observations focused on the actual process of pit construction. We noted that before a pit is excavated, the larva moves just beneath the substrate, flicking sand continuously as it plows backward across the terrain. When a larva moves backward in this fashion, it leaves a narrow furrow in front of it, much as would be created by dragging the tip of your finger lightly across the sand. Because the path of the larva can seem tortuous, these movements are called doodles, hence another popular name for the antlion: doodlebug.

The success of both doodling and pit construction requires the antlion to overcome several formidable problems. Digging through sand with efficiency is one. The antlion accomplishes this by utilizing a variety of

Pit Obstacle-removal Techniques



Tangential Flick for obstacles up to 5× the antlion's body weight



Lateral Flick, 5× to 8× body weight

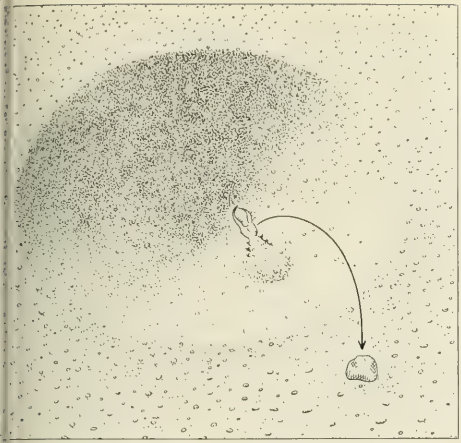
morphological specializations. Foremost among these is the shape of the larva's abdomen, with its relatively blunt anterior end gradually tapering toward the posterior—the direction of movement. This shape enables the antlion to slide easily backward through the dense substrate when the hind legs move forward on their power stroke. The animal is also aided by its hair tufts, which bend forward when the animal moves backward, but which fan outward and anchor it when the legs move back on their return stroke. (This prevents the animal from simply oscillating back and forth in the sand.) In addition to functioning as anchors, one particular group of tufts on the ventral surface of the abdomen seems to have an additional function. These tufts occur along two longitudinal ridges and the hairs growing from them are longer than those on most other parts of the body. This arrangement actually creates two furrows relatively devoid of sand. As a result, when the larva's hind legs move backward on the return stroke, they move within these air pockets, thus encountering far less resistance than when moving through the sand on the power stroke.

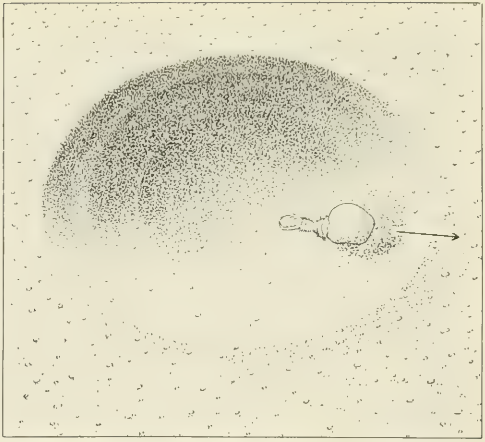
Because pit construction is almost invariably preceded by some amount of doodling, biologists have always assumed that doodling is important in enabling the antlion to sample the environment and locate a suitable site for its pit. It has never been made clear, however, exactly which parameters of the environment provided the selection pressure for the evolution of doodling. For example, it is doubtful that substrate type is the key parameter, because antlions are not terribly fussy about the medium in which they dig. The published literature shows that pits have been found in quartz sand, red sandstone, dust, humus, rotted wood, gypsum, and even coal ashes. The only consistent requirement seems to be that the substrate be composed of small, dry, loose particles. Furthermore, because these variables are properties of the substrate itself, the larva is undoubtedly capable of responding to them without ever raising its head above the sand. But this is precisely the outstanding feature of doodling. As the antlion pushes its way backward through the sand, it repeatedly flicks sand upward, thus raising its head above the soil surface. It would make sense, therefore, if the primary adaptive function of doodling enabled the antlion to respond to environmental cues whose energy source was capable of stimulating receptors located on its head. The obvious candidates for this job are the well-developed eyes, which are situated on both sides of the head, close to the base of the mandibles. But what does the perception of light have to do with locating a site for a pit?

One indirect clue, pointed out in practically every field study of antlions, is that pits are seldom found in greatly exposed areas. They tend to be concentrated instead beneath t or other natural overhangs. The vantage of such locations is gre protection from the sun, large an traffic, wind, and rain. Althoug cannot be certain at this early s of the project, our studies have vided some circumstantial evid that the larvae actively locate t sheltered sites by means of a vi orientation process that takes p during doodling.

When we released captured lions within our experimental much of the sand surface was cov with patches of shade produced b surrounding trees and the early m ing sun. The larvae doodled in m directions during early morning, all activity ceased throughout the test part of the day—late morning early afternoon. Late in the a noon, however, a second burs doodling occurred. As the sun hea westward toward the horizon, shaded areas on the sand su gradually receded eastward. By time, all the antlions were also dling in an easterly direction, some minor scattering, so that by set the experimental plot was cov with a series of relatively straight parallel doodles. Some of the antl were actually keeping pace with moving shadows. Although it was clear whether the antlions were sponding directly to the darke areas of shaded sand, to some as of the leaf and branch pattern fro trees, or to temperature gradati

Alan Iselin


al Flick, 10× body weight


Radial Push, more than 10× body weight

y were all clearly moving toward shaded locations.

ometime between 5:00 and 7:00 ., each antlion abruptly ceased dling in a straight line and began nove in an almost perfect circle. construction had begun. As each lion circled backward, it contin- to flick sand up over its body and of the circular furrow. When it npleted the first circle, it moved ard and continued along another le of slightly smaller diameter. larva continued this pattern of vement until an inverted cone was med, then it took up a predatory ition and ceased activity.

n antlion often finds its backward vement during pit excavation cked by small stones, pieces of gs, and other debris. One response this situation is for the antlion to r its course slightly and simply ass the obstacle. Unless the stone exceedingly massive, however, re are several reasons why this is the most effective adjustment. If antlion shifts its circling pattern wardly, around the pebble, it will y encounter the pebble again while avating the interior of the pit. On other hand, if the antlion bypasses stone by moving inward, the ob- cle winds up perched near the rim the crater. Unfortunately, this ns out to be only a temporary solu- n because the action of wind and sing animals could easily cause pebble to fall back into the pit. In lition, obstacles around the rim of the pit may cause potential prey organisms to alter their direction away from the pit.

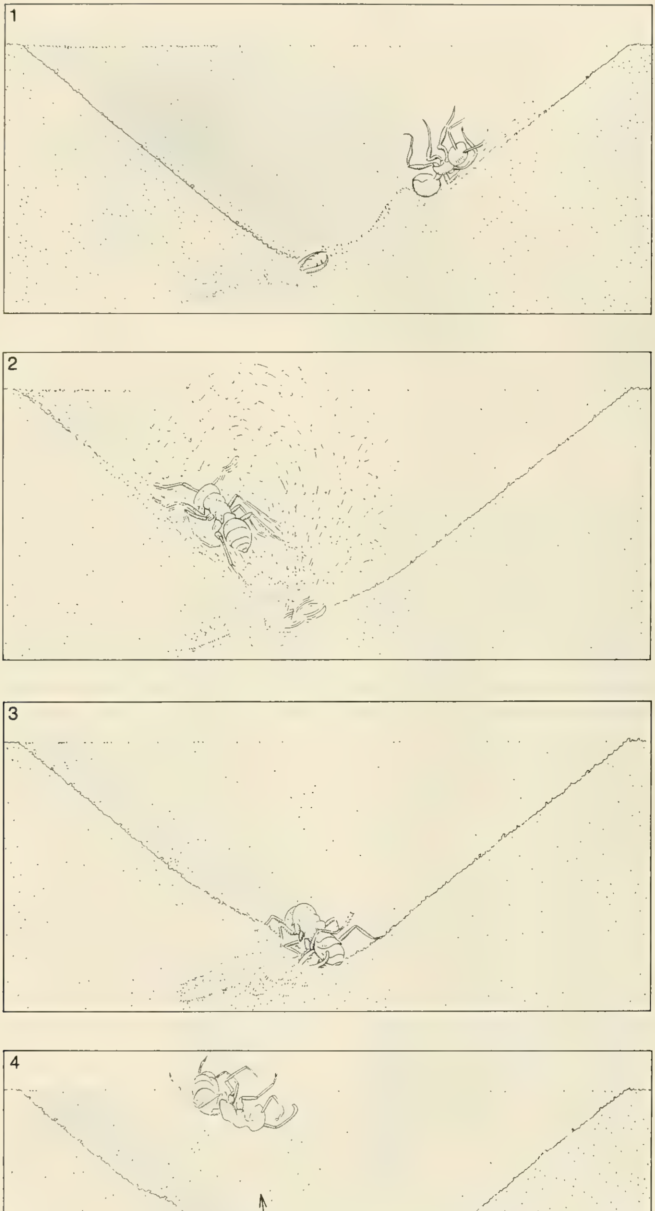
In order to study the antlion's response to obstacles, we collected several dozen larvae, ranging in weight from 14 to 54 mg, and placed them in coffee cans filled with fine sand from their field environment. Each evening when the animals were engaged in pit construction, we carefully placed pebbles of varying weight directly in their paths. We found that the strategy of altering the direction of circling is indeed used by the antlion, but only when the obstacle is so massive that it cannot be budged. When this occurs, however, the antlion doesn't merely move around the pebble. Instead, it actually stops circling, doodles to another area several centimeters away, and excavates an entirely new pit. If the obstacle is at all movable, however, the antlion promptly removes it. We discovered that the *Myrmeleon* larva possesses at least four different mechanisms for removing pebbles from its pit, depending upon how heavy the pebble is in relation to its own weight.

Very small pebbles, weighing from a fraction to approximately five times the weight of the antlion, are treated like ordinary grains of sand. The antlion moves backward under the pebble until its head is positioned directly beneath and then flicks the obstacle out of the pit by catapulting it upward and back over the long axis of its body. Because the path traveled by the pebble is along a tangent to the circular groove in which the antlion is digging, we have termed this mechanism of pebble removal a "tangential flick."

A slightly heavier object, between five and eight times more massive than the antlion, elicits a noticeably different response. Although the antlion assumes the same position as for a tangential flick, it now heaves the pebble laterally, perpendicular to its body axis, away from the center of the pit. The adaptive value of this "lateral flick" is that the pebble now has to travel a shorter distance in order to clear the outer wall of the pit.

If the pebble is approximately ten times the weight of the larva, the insect switches to a third mechanism, one that we call a "radial flick." The name of this procedure stems from the fact that the antlion now rotates its body 90 degrees, lining itself up along the radius of the circle, with its head facing toward the center. In this position, as in the previous lateral flick, the pebble is thrown out along the shortest path possible. The advantage to the antlion of taking this position for heavier pebbles is that by heaving the stone backward along its body axis, the animal is using its most powerful stroke.

The radial flick is the last mechanism available to the antlion for catapulting objects out of the pit. When it encounters an obstacle that is heavier than ten times its own weight, it initially makes several at-

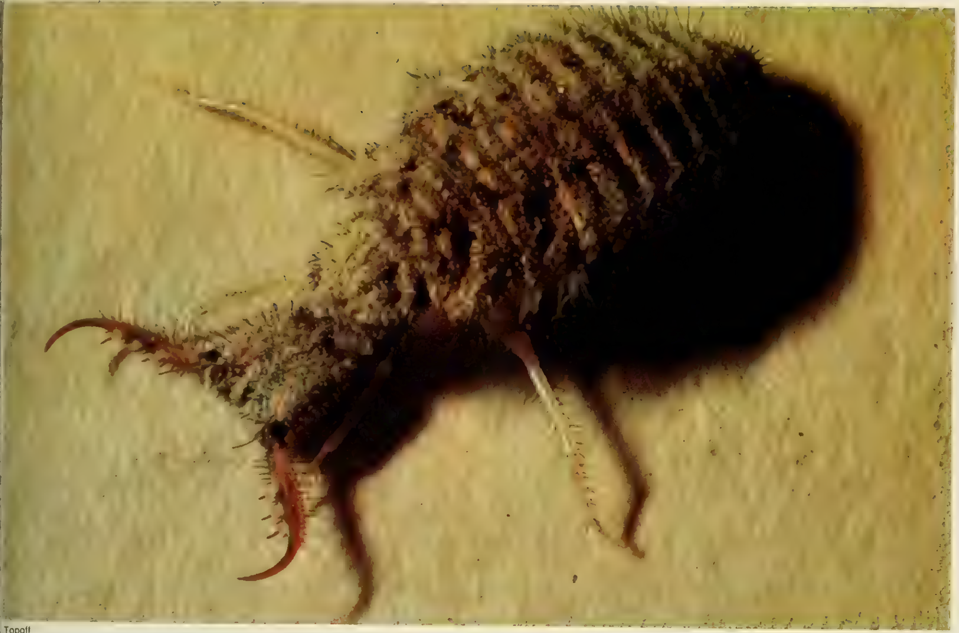


Alan Iselin

A wandering ant has stumbled i
an antlion's pit. Alerted by
cascading grains of silt loosed b
the ant, the antlion awaits its pr
with poised mandibles (1). Havi
eluded its predator's first attack
ant scrambles up the 38- to
42-degree slope of the pit in an
attempt to escape. The antlion
furiously flicks silt upward,
preventing the ant from gaining
purchase (2). After the ant is fin
trapped, the antlion sucks out its
body fluids (3). Finished with its
meal, the antlion flings the prey'
carcass out of the pit (4).

tempts to toss it into the air. Bu
the animal's musculature cannot p
vide the necessary power, the peb
merely jiggles slightly on the surf
of the sand. After several futile
tempts at flicking, the antl
emerges from the sand, places the
of its abdomen against the stone,
slowly pushes it radially up the sl
of the crater and out of the pit, st
ping only after the pebble is sev
centimeters from the rim. Then
antlion does an about-face, mo
back down the slope, reenters
sand, and resumes excavating.

Observing an antlion remov
pebble by means of this radial p
is reminiscent of the legend of S
phus, king of Corinth. In Gr
mythology, Sisyphus was the cr
iest of men. When Death came
him, he instructed his wife not
offer the traditional sacrifice to
dead. Upon arriving in the und
world, however, Sisyphus co
plained that his wife was not do
her duty. He even managed to c
vince Hades, god of the underwo
to permit him to return to the upp
world to punish his wife. It was
a trick, of course, and when Sisyp
returned he and his wife lived
gether for many more years. After
tering the underworld for the sec
time when he died of old age, Si
phus was handed a most unusual p
ishment. His task consisted of roll
a huge rock up and out of a d
crater. Each time the boulder nea
the rim, however, it rolled back do
to the center of the crater and he



Topoff

The hairs on an antlion are adaptive in prey capture. When a victim attempting to escape tugs at the predator, the hairs flare outward and anchor the antlion.

tart over. Thus Sisyphus's task d an eternity.

n antlion is not usually con- ted with precisely the same prob- Sisyphus had. Because most nat- y occurring stones are irregularly ed and have somewhat flattened aces, they do not automatically down into the pit if the animal entarily loses contact. The ant- 's task is also simplified in that the al push need not be executed in continuous movement. Instead, nimal might push the stone part- up the slope, stop for several sec- s, and then resume pushing.

/e decided to put the antlion to the nate Sisyphean test by repeating obstacle experiment, this time g perfectly spherical ball bear- . The result was an exhibition of ncing that would be the envy of circus seal. Once again, the ant- emerged on the surface of the l after several unsuccessful at- pts at flicking a heavy steel ball. aced its abdomen against the ball started pushing slowly up the e of the crater. Almost immedi- y, however, the smooth ball an to shift position so that the tip e larva's abdomen was no longer applying force through the center of the ball. The antlion responded with a series of compensatory movements, similar to those one would make while balancing a broomstick vertically on the tip of an outstretched finger. Whenever the ball slipped either toward the right or left, the antlion reacted by shifting its abdomen in the same direction just far enough so that it was properly recentered on the ball.

When we repeated this experiment several times, it became obvious that we had just about approached the limit of the antlion's capability for behavioral adjustment. As the animal pushed the sphere up the slope, its abdomen was in an almost constant state of movement. More times than not, however, the larva lost control, the ball rolled down to the center of the pit, and the larva, like Sisyphus, had to start again.

Although placing pebbles and ball bearings in the paths of antlions during pit construction may at first glance seem to be little more than clever tricks designed by scientists to amuse themselves, these experiments can answer questions of fundamental importance. Animal behaviorists often use the term "stereotyped" when referring to the behavior of an organism whose capacity for adjusting is relatively limited. A serious problem arises, however, when this conclusion is reached as a result of studies conducted only in the species' natural environment. On the one hand, it may indeed be true that the organism simply does not possess the neural complexity necessary for a wide range of behavioral flexibility. On the other hand, it is also possible that novel situations arise infrequently, so that the organism only occasionally has the opportunity to demonstrate its complete range of behavioral patterns. This is one of the principal rationales for conducting carefully controlled experiments in a laboratory setting. By testing the organism under a variety of experimental conditions, the investigator can often elucidate, in a short time, a range of behavioral processes that might take many months of field study to uncover. Although our class experiments represent only the very first stages of a thorough research program, we have already demonstrated that the antlion *Myrmeleon immaculatus* possesses a far greater potential for behavioral adjustments than had previously been reported.

Although the excavation of pits by antlions has often been compared with the building activities of other arthropods, such as spiders, caddisflies, and honeybees, our findings concerning the antlion's behavioral plasticity suggest that the analogy is a poor one. Consider, for example, the beautiful cartwheel pattern of the orb web built by *Araneus diadematus,* one of the master weavers of the spider world. If the spider merely moved from one support to another, haphazardly depositing threads of silk along the framework, the result would undoubtedly be little more than a silky mass (and probably a silky mess). The formation of an optimal snare requires *Araneus* to utilize a precise sequence of its own intrinsic behavioral patterns and not rely on being helped by factors in its external environment.

In the case of the antlion, by contrast, the evolutionary process has taken a very different direction. The success of the antlion's behavior is guaranteed precisely because the organism is adapted for taking maximum advantage of the physical properties of the substrate in which it is excavating. As a result, its behavior can be quite variable, yet still produce an inverted conical pit with ideal trapping properties.

To understand how this works, consider the following simple exercise, one that anyone can perform at a sandy beach. A cylindrical pail is filled with the dry sand found far from the water's edge and carefully inverted on a flat surface. The resultant mound of sand will not have the cylindrical geometry of the pail. Because the sand is dry, particles slide past each other as soon as the pail is lifted, so that the mound will be relatively cone shaped. The angle by which the wall of the cone slopes upward from the base will always be similar as long as the same substrate is used. In earth science, this angle is termed the "natural slope" and represents the steepest angle under which an unbraced wall of material will remain in stable equilibrium.

Although this example is for the formation of a cone whose apex rises above the substrate, the same geologic principles are operative when sand is removed during the formation of a funnel-shaped pit. To demonstrate this, we collected several buckets of silt from the antlion's habitat, and with a small vacuum cleaner sucked up particles until we created a pit with a diameter comparable to that of a larva's pit in the field. We then measured the slopes of the walls of our artificial pits and found that they ranged between 39 and 43 degrees. When we measured the slopes of antlion pits in the field, the calculated range was 38 to 42 degrees. Our conclusion is that many of the features of an antlion's pit result as much from the action of physical forces operating on the silt particles as from the behavior of the antlion itself. Thus, it is not surprising that the antlion exhibits no rigid sequence of movements during pit construction. The antlion may excavate the initial circle by moving either clockwise or counterclockwise, and the direction of circling may change several times before the pit is completed. Another common variation is for the antlion to stop circling altogether and cut straight back and forth across the center of the depression, only to resume circling after an unpredictable number of such crossings. Finally, the antlion may simply spend varying periods of time in the center of the depression and flick headfuls of sand without changing the position of its body. As long as the antlion remains within the area delineated by its initial circle and spends enough time tossing out sand, the result will always be a first-rate trap. □

Having encountered a stone during pit construction that is more than ten times its body weight, an antlion pushes the obstacle up and over the rim.

Howard Topoff

esieged Reefs of Florida's Keys

hillip Dustan

tloads of sun- and water-
shipers inadvertently,
mercilessly, assault
e delicate refuges
arine life

ore than one hundred known
wrecks lie along the mangrove-
d coastline of the Florida Keys,
ns and coral reefs having claimed
victims here since the sixteenth
ury.

ıe best-known wrecks are those
e Spanish plate fleets. Laden with
ure from the conquered Aztec
Inca empires, these ships assem-
in convoys near Cuba before
ing across the Atlantic with their
ite to Spain. Upon leaving Cuba,
usually sailed north, riding the
Stream through the narrow
its of Florida. In 1733 a particu-
savage hurricane trapped the
in the Straits and drove twenty-
ships onto the reefs. During the
-year period following the disas-
the Spanish government suc-
ed in salvaging twelve million
dollars worth of treasure. Success, however, was only partial for some of the ships lay in water too deep for divers. For the next 200 years, the wrecks remained buried beneath the sand; then in the late 1950s and early 1960s, a few adventurous divers recovered an additional four million dollars worth of silver and gold.

Like those of the 1733 plate fleet, the fragile hulls of many other ships have been split open by the sharp coral. Common to all these catastrophes has been the understandable lack of concern of captains and crews for the damage their vessels inflicted upon the reefs.

The Keys, a narrow, 166-mile-long band of islands, stretch southwesterly from the east coast of south Florida to the Dry Tortugas. At their northern end are fossil reefs formed during the Pleistocene when sea levels were higher. The lower keys—from Big Pine to Key West—are composed of oolitic sediments and bear a close resemblance to the geologic structure of the Bahamas. The keys support an assemblage of vegetation related to that of the West Indies. Although logging operations in the 1800s erased most of the large lignum vitae and mahogany trees in the area, second and third growth trees are now common.

Today these islands are a haven for vacationers seeking the warm sun during winter months. Tarpon, bonefish, and sailfish lure fishermen; osprey, roseate spoonbill, white ibis, and many other bird species bring bird watchers; and the beautfiul offshore reefs attract divers. In addition, the keys support a multimillion-dollar commercial fishing industry.

In the early 1960s environmentalists, concerned that the richness and beauty of the reefs were disappearing under the demands of coral and fish collectors and treasure seekers, began a campaign to preserve the reefs. Their efforts, led by John Pennekamp, an editor of the *Miami Herald,* and Gilbert Voss, a marine biologist at the University of Miami, resulted in the establishment of the nation's first underwater park—John Pennekamp Coral Reef State Park. In conjunction with the newly formed federal marine sanctuary, the park encompasses more than a hundred square miles of sea floor off Key Largo, an area possessing some of the most prolific reefs in the keys. Within its boundaries are 35 species of coral and more than 500 species of fish. The collecting of corals and fish is forbidden within the park, but line fishing, lobstering, and commercial fishing are permitted.

Coral reefs, one of the richest and most productive ecosystems on earth today, are rapidly becoming imperiled. Man is directly responsible for their decline. In Hawaii, the once pristine Kaneohe Bay reefs are covered with layers of sediment as a result of land clearing. Sheets of green algae, nourished by sewage, have encrusted much of the sea floor near the reefs. In Sri Lanka, coral is mined as a building material. In the Philippines, divers collect coral and ship it to the United States where it is sold in curio and aquarium shops. And in Palau, plans are in the making to construct an oil refinery and superport in the midst of the reefs.

Although the reefs in John Pennekamp Coral Reef State Park have not suffered this kind of massive damage, they are threatened in another way—by the skyrocketing upsurge in scuba diving, snorkeling, and leisure boat-

amount of damage that boat
ks inflict upon coral reefs
nds on the type of coral
lved. Star coral, top, a
sive form, withstands weight far
r than elkhorn coral, bottom,
se branches break easily. One
th after the elkhorn coral was
aged, tissue began to form over
roken branch ends. After
e months, new polyps, aligned
rd the direction of the waves,
n to grow over the tissue.

Phillip Dustan

The Keys, a 166-mile-long islan
chain, curve southwesterly arou
the tip of Florida. Coral reefs
and mangrove thickets, habitats
of abundant marine life, once
surrounded all the islands.

ing. The park's popularity has provided us with a natural laboratory to probe the question of coral-reef survival under heavy recreational pressure. In 1974, more than 300,000 people paid admission to use the park. In 1975, paid attendance was estimated at 400,000. Most of these people entered the park on commercial diving boats.

Coral reefs are one of the few ecosystems that construct their own geomorphology. Covered by a veneer of countless fragile corals, algae, and other organisms, all attached to a limestone framework, each reef is gradually formed by the accumulation of carbonate sediments. As the organisms on the reef surface die, their skeletons provide an anchor for additional living corals. Each coral lives according to the laws of natural selection. Most species have specific habitat requirements and thrive only in environments that fulfill their needs. The result is the growth of asymmetrical reefs with distinct patterns.

The main direction of reef growth is into the prevailing seas, a community adjustment to wave conditions. The geometrics of coral species reflect the intensity of water motion in their individual habitats. Round, massive forms are able to resist the power of waves. Elkhorn corals, *Acropora palmata,* with their major axis growing parallel to the swell direction, distribute the power of a wave. Many species of gorgonians, the flexible sea fans, grow perpendicular to the average direction of the surge, presumably to maximize feeding efficiency. All coral forms seem to allow the organisms to catch particulate food while dissipating hydrodynamic energy most efficiently.

Researchers can use these species' responses to changes in their positions to study the effects of man on coral reefs. When corals are overturned, for instance, they grow new branches, or edges, oriented to the direction of the prevailing seas. Much can be learned about the survival ability of reefs by studying their rate of regeneration.

We tried to ascertain the vitality of the reefs in John Pennekamp Coral Reef State Park between October 1974 and December 1975. Damage to the reefs there is being caused not only by physical but also by chemical interference. In 1975, the greater Miami area produced 84 million gallons of sewage per day, which was pumped into the ocean. Some of this enters the inshore currents, which flow south past a portion of the reefs. The resultant damage to reefs is difficult to detect over short periods of time. A 10 percent decrease in growth rate, for example, would have a profound effect on a reef but would not be apparent for about twenty-five years. Our studies on Carysfort Reef in the park, however, revealed some species suffering mortality rates as high as 22 percent over a six-month period. Chemical pollution also affects reproductive rates and the ability of larvae to settle.

Physical damage, far more direct and localized than chemical damage, is easier to assess. On the Pennekamp reefs, divers, snorkelers, and their boats and associated equipment
primarily responsible for phys
damage. Divers damage corals by
advertently scraping off the anim
tissue. The corals replace this tis
in much the same way our own bo
heal a scraped knee. Divers and s
kelers also break branches of
more delicate corals with fin kick
by standing on the sessile creatu
As well adapted as they are to
forces of the sea, branching corals
no match for a 150-pound huma

Probably the most widesp
damage to reefs in the park res
from the anchoring of small bo
Larger commercial diving boats d
too much water to anchor dire
over the reefs, and out of resp
they usually anchor in sandy ar
Small privately owned boats, h
ever, often glide into the shallows
anchor directly on the reef. Most
chors weigh more than five pou
and, like humans, can easily dam
the corals by lopping off branches
gouging surfaces. The damage
not cease with the settling of the
chor. While the boat swings in
sea, anchor chains and ropes ofte
more damage than the anchors th
selves. And as the anchor is weig
it often bounces over the bottom

The damage caused by a single
chor is restricted to a small area,
some reefs are heavily trafficked
a busy day, up to two hundred b
visit Molasses Reef, only two a
in area; on most other days,
average is twenty to fifty boats.
chors are dropped on the reef s
15,000 times each year. If each
chor damages an area of only s
sixteen square inches, the cumul
damage over a year's time is appr
mately one-tenth of an acre.

Each wound inflicted on a cor
other reef-dwelling organism dis
the growth of the entire reef. The
mal living routine of an orga
stops while it expends energ
repair the wound—energy norm
used to capture food, to reproduc
to grow and add to the bulk o
reef. Coral reefs exist because th
rate of deposition exceeds the ra

truction by the relentless sea. Ge-
gists estimate that reef growth in
Caribbean ranges between one
fifteen feet every thousand years.
, corals themselves grow at a rate
would result in reef growth ten
ne hundred times greater. Only a
ll part of the deposition, how-
r, remains behind as reef rock.
f growth rates of the corals are re-
ed by damage, rates of net accre-
may be similarly reduced. Only
nall change in the growth rate is
essary for a drastic decrease in net
growth over the long run. To the
itiated eye the change would be
n well-formed reef to coral-en-
ted rubble (a type of reef struc-
) within decades.
robably the most dramatic imme-
e damage suffered by reefs is that
sed by boat wrecks. Although this
s not happen with great fre-
ncy, the resultant damage clearly
ws the fragility of reefs. On No-
ber 2, 1974, the 38-foot trimaran
ya blundered onto Key Largo Dry
ks Reef, having just set out from
t Everglades bound for Los An-
s. She was reaching before a fif-
- to twenty-knot wind, with seas
estimated six to nine feet high,
n a navigational error put her in-
the line of the reef. The hull
unded on a shallow patch of a
l spur, then smashed head-on
er full sail into the reef flat, a
ve of delicately branching elkhorn
l. *Maya*'s rudder gave way first,
owed by the belly of her main
, which, once ripped open, dis-
ged the entire contents of the en-
room and cabin into the sea. Dis-
d and heavy in the water, she
ndered as her crew tried desper-
y to save her. But the sea had
led *Maya*'s fate and she pounded
leath on the reef. A day later all
remained afloat was one sponson
a few bits of wood. Like that of
plate fleet of 1733, *Maya*'s re-
ins lie scattered on the ocean floor.
Maya's wreck site covered some
00 square feet. The impact
shed the branching corals to rub-
. Massive corals were abraded or
t open, and many living sessile
atures were killed or exposed to
dation. Fish populations were
porarily disrupted; their terri-
es and coral cave refuges de-
yed. Many of the small pomacen-
fishes were scarred in battles over
redistribution of new territories.
er fishes hunted the area for
nges and other invertebrates ex-
posed when the corals were overturned. Although the fish adjusted to the new conditions quickly, recovery of the coral populations will take many years.

In an attempt to ascertain the extent of damage to the reef, we had the largest colonies dated by carbon 14 analysis. The results showed that the skeletons had absorbed carbon 14 from atomic weapons testing held in the last thirty years. By correlating reef-growth rate with the location of carbon 14, we determined that the largest reefs overturned at Key Largo Dry Rocks were somewhere between fifteen and forty years old. Although new coral has begun to grow on the upset structures, the growth of the entire reef was set back a considerable amount of time. During the year following the wreck, we monitored the changes in the reef and the regrowth of damaged corals.

Many of the pieces scattered on the bottom had died, their deaths apparently being related to their positions and sizes. Large pieces fared much better than small ones and pieces in semiprotected spots survived longer than those in exposed or highly protected places (the former were tossed about by swells and the latter did not receive sufficient sunlight). In some areas where corals had collapsed onto other parts of the same colony, their tissues had fused and the two parts grew together. Those pieces still living had begun to regrow and reorient their skeletons to prevailing sea and light conditions.

Corals first respond to damage by growing a thin layer of new skeleton and tissue. This takes from weeks to months, depending on the size of the wound and the species of coral. Elkhorn coral grows new tissue and skeletal material at a rate of about half an inch per month. Before the coral can cover a wound, however, other organisms colonize the bare skeleton in an ecological succession starting with diatoms, then blue-green and red algae. In the process of healing, the coral must overgrow this algal jungle.

New polyps then form on the surface and branches begin to grow. Local environmental conditions affect their direction and shape. Interestingly enough, we found that the rate of growth of new branches was slightly greater than that of undamaged ones. The former, however, were thinner; thus, the net amount of skeletal material deposited may be the same. Because the wreck changed

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the water-flow patterns on the ree gouging out a new channel throug the over-all pattern of regrowth is uncertain. One year after the wr the damaged reef appears li changed; the swath cut by *Ma* hull is still a gaping hole.

The wreck of *Maya* was an logical disaster to Key Largo Rocks. Unfortunately, it was not only incident of its type within boundaries of John Pennekamp C Reef State Park in 1974–75. Du the sixteen months I spent workin the park, there were at least five o such incidents; happily none wer catastrophic as *Maya*'s demi These accidents do not include merous propeller groundings, wh keep the local propeller repair sho business year-round. Other man duced physical damages incl breakage and entanglement by f ing lines and lobster traps. Clea lush reef growth cannot take plac the coral community has to put sig icant amounts of its energy bu into repair and regrowth.

Inevitably, the question arises a what can be done to protect the re and still allow man to enjoy the source. From our observations, chors appear to be the greatest m ace to reefs. One possible solutio to affix permanent moorings to bottom, a suggestion made seve times by Gilbert Voss, but to no av Another possibility is to mark the r with a circle of buoys and forbid choring within that circle. This wo not only protect the corals but wo also protect the divers from injury boats, often a serious threat durin crowded day.

Perhaps not all the reefs in the p should be open to human traffic. P tected wilderness areas give natur breather and tend to enhance the ar around them as well. Reefs ne space; some could easily be put limits to divers and boats. Oth could be closed during peak rep ductive seasons to allow disser nation of larvae to proceed und turbed by man. Reef use could a be rotated to allow time for recove from intrusion by man and his vices. More heavily visited re might sustain less damage if provid with marked trails. Whatever management scheme, some eff should be made to protect the re now, for these delicate ecosyste cannot long endure man's continui pressure—his pollution and his l sure-time-related misuse of reefs.

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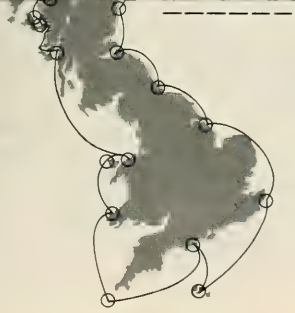

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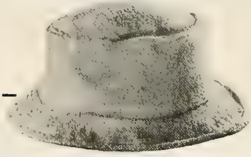

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A Matter of Taste

by Raymond Sok

Humble Pie

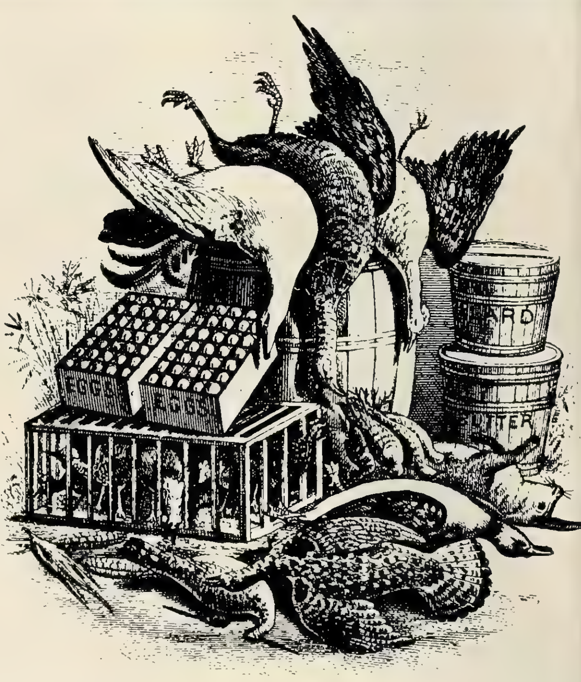
Unjustly maligned, English food is a gutsy old cuisine, but hard to find

Gastronomes in search of a scapegoat to roast invariably turn toward England. Take Talleyrand, the leading French epicure—and statesman—of the Napoleonic period. "England," he pronounced, "has an infinitude of religions, but only one sauce." Talleyrand was wrong, of course. England then, as today, had one established religion and several sauces of its own, roughly as many, indeed, as Italy. But, facts to the contrary notwithstanding, Talleyrand's gist—that England is a place of great moral tolerance for plain food—is an article of faith for many well-traveled Americans even at this late date.

"London," they will concede, "is a great city—civilized, hospitable to eccentrics, and filled with parks. the food is unspeakable." You have met people like this. I known one extremely well. I was

Then, last fall, on a day stereotypical British dampness gloom, in the plushly remod home of the novelist Frederick ryat (now a first-class hotel) on south coast at New Milton, Ha shire, I fell, open-mouthed and a barely stifled cry of pleased prise, upon that rara avis, a mag cent English meal.

The main course was, literall rare bird, a lightly roasted gro with high and bloody flesh. nished with homemade "ga chips" (small, crinkled potato ch and English bread sauce (see re below), this dish had the struct logic, and uniqueness that impl cuisine: an orderly, culturally co



gustatory world view. And so, erted from culinary bigotry, I am ready to eat humble pie.

umble pie is, in fact, a case in t. It is a real English dish, but like any real English dishes, you will y, if ever, see it in British restau- . They serve French food, Italian , featureless convenience foods, hing but English food. As a re- if you want to find humble pie, look in a book and see that it has ing to do with humility. It is a pie posed of all manner of meats, hare to bacon, and sometimes . Originally, it was made from nnards, or numbles, of deer.

ow just as "napple" became "an e," so numble turned into "an le," which, since a dropped ch" was at some point assumed, ved into "humble" and sounded poor food. If it had been called *ût des abats de chevreuil en te,* you and I and the inspectors e *Guide Michelin* would long ago beaten a path to the brilliantly aic Burgundian inn that served it *spécialité.*

s it happens, numbles does have ench or, at least, an Anglo-Norman ancestry. It goes back ultimately e Latin *lumbus,* for "loin." The connection with innards is obvious, and the etymology also illustrates the common Roman background of French and English food.

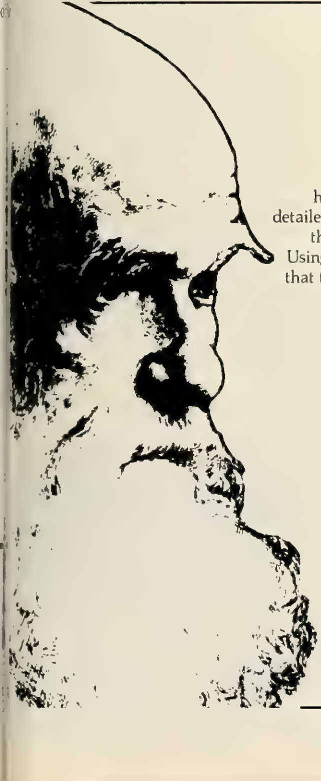
Medieval menus in both countries derive directly from the Mediterranean heritage of the Roman Empire. The oldest French cookbook, the *Viandier* of Taillevent, dates from the fourteenth century and lists sauces of the same sweet-and-sour type we know from recipes in Apicius and from other ancient descriptions in Latin. What we think of today as French cuisine does not begin to show up in cookbooks until the eighteenth century.

Roughly speaking, the same kind of Romanesque diet seems to have dominated the English table well into the modern period. Much evidence for this exists. Madge Lorwin has collected some representative recipes and modernized them for home use in her recently published *Dining with William Shakespeare* (Atheneum). Here you will find the roast birds, meat pies, pickled and salted fish, and homely grain puddings and breads that fed Falstaff and Rabelais and anyone else above the poverty line in Europe before 1700 and even later.

From this perspective, beef-and-kidney pie can be properly viewed, not as a specifically British concoction, but as a survival from premodern European cooking. The grouse I ate is a comparable anachronism that harks back to a time when gamy birds dominated banquet tables in France and England. Not only pheasants, grouse, and partridge, but such abandoned delicacies as stork, heron, crane, and swan were avidly consumed by British and French royalty.

Organ meats of every kind also fed the gentry on both sides of the Channel. But vestiges of this more diverse, preindustrial diet persisted in England longer and more visibly because no other native cuisine developed to supplant it. Lytton Strachey wrote in this century of country meals that included "for breakfast the inside of a she-goat, at lunch sow's udder trimmed with tripe and parsley smothered in thick white sauce."

You and I will probably never face such fare, no matter how deeply we penetrate the English countryside, but there is no understanding British food without taking into account this gutsy, old-fashioned background. Salted fish—kippers or smoked haddock—for breakfast is not an Anglo-



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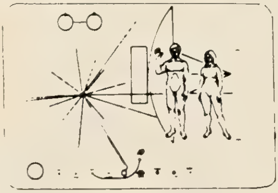

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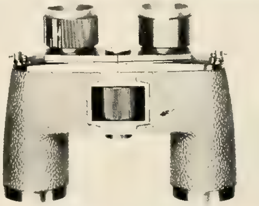

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Saxon quirk. It is an edible remind of an era before refrigeration. Li porridge, it gives us a taste of plain food of the past.

This plainness, which pervades a thentic British cooking, can be su lime, as with my grouse, whose fle had been carefully hung, exposed the open air, so that it would decor pose, turn tender, and develop a f vor of powerful sophistication.

The question remains: Why d this plainness or, rather, this fideli to antique methods and tastes prev in a country that otherwise led Euro into the modern age? Perhaps the a swer lies buried in some impenetrab recess of the English character. B there are at least two good reaso one can point to, the Puritan revol tion and the Napoleonic Wars. Wh French chefs were inventing mode French food in the seventeenth ce tury, England tightened its belt a restrained its gastronomic impul under the skinflint gaze of Cromw and his lieutenants. When Ta leyrand's chef, Carême, arrived fr France in the early nineteenth ce tury, he brought a dazzling new sty of food, but he also bore the hat stamp of Bonaparte's France.

Since Napoleon, down to t present day, French "kickshaw (from *quelque chose*) have offend English national pride. Elaborate di ing was, in a sense, equivalent French supremacy. Yet even as 100 percent Englishman defensive claimed plain food—roast beef a overcooked vegetables—as his n tional heritage, he, conversely, ced gastronomic cleverness to the Fren and hired them to cook for him wh the mood for something grand sailed him. Escoffier worked at Savoy Hotel in London.

This was an outstanding but not isolated instance. To eat well in Lo don or elsewhere in England, y find yourself going to a French or least a foreign restaurant nine tim out of ten.

Good British food is a chore to cate outside private homes. Some ceptions prove this rule, howev usually luxury items—oysters, do ble cream, strawberries, and salm Then, too, there are certain sp remnants of empire, notably curr and that curried Anglo-Indian com nation of rice, haddock, chopp egg, and currants called "kedgeree But the true spirit of British cook is still kept alive, here and the despite the depredations of the bl

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of 15 years of rationing, of lost "dominion over palm and pine," and plummeting pounds. You have to look and ask. And if you are very good, a nannylike waitress will some day serve you a slab of silverside (the corned top round of beef) and then some meltingly delicious fresh figs or a slice of Christmas Stilton. "Oh, to be in England. . . ."

Bread Sauce

1 cup milk
1 small onion, peeled
2 cloves
1 cup breadcrumbs
¼ cup heavy cream
Salt
White pepper
Nutmeg

1. Bring milk to a boil in a large saucepan. As soon as it starts to foam up, reduce heat so that the milk simmers gently.
2. Take the onion, stick the cloves into it, and add it to the milk. Then stir in the breadcrumbs.
3. Continue simmering until the breadcrumbs have thickened the sauce, about 5 minutes. Stir continuously.
4. Stir cream into the sauce and season to taste with white pepper, salt, and nutmeg.
5. Remove onion and discard (with cloves) before serving sauce with feathered game or poultry.

Yield: About 2 cups

Plain Scones

2 cups flour
¼ teaspoon salt
3 tablespoons shortening
1 teaspoon sugar
½ cup milk, approximately
¼ cup yellow raisins

1. Preheat oven to 450 degrees.
2. Sift the flour and salt together.
3. Cut in the shortening and sugar.
4. Moisten with milk, gradually, until you produce soft dough.
5. Grease a baking sheet.
6. On a lightly floured surface, roll out the dough to a thickness of roughly ¾ inch. Cut the dough into squares or circles.
7. Bake on the greased baking sheet for 10 minutes.

Yield: 6 servings

Raymond Sokolov's most recent cookbook is The Saucier's Apprentice, *a guide to French sauces.*

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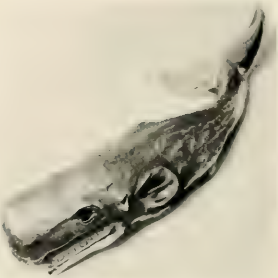

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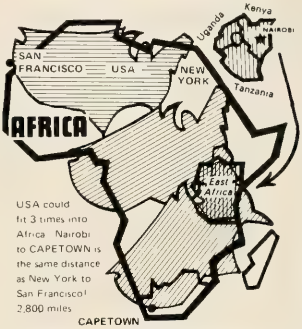

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Announcements

From April 4 to May 1, the Museum will feel the influence of **R. Buckminster Fuller**—architect, engineer, philosopher, educator, and writer, but probably best known as designer of the geodesic dome. On May Day, at 3:00 P.M. in the Museum auditorium, Fuller will discuss his ideas about design, learning, youth, history—any number of topics. He never lectures on a specific subject; rather, he communicates in a stream of consciousness, presenting his thoughts—usually focused on common sense and efficiency—with humor, charm, and enormous imagination. If Fuller's appearance follows the precedent set last year, his audience will leave the auditorium inspired by the infinite possibilities he presents.

To introduce Museum visitors to some of his concepts, a retrospective exhibit of photographs of Fuller's designs and structures will go on display on April 4 in the Center Gallery, near the People Center.

Tickets to the May 1 lecture available by mail or at the se floor information desk. Admis for Participating and Donor Mem will be $4.50 with a limit of two $5.50 for Associate Members an public.

The Education Departme Spring Series of **Workshops** **Children** will begin the third w end in April and continue throug third weekend in May. Each w shop is taught either by a depart staff member or by a profession the particular study area. The fol ing sessions will be available: ploring Earth's Past, The Natur New York City, Ecology of an U Park, Nature Photography, and ploring with the Microscope. workshops meet on either Saturda Sunday and most include field tri Central Park or other parks in York City. The cost of each w shop is $20. For further informa call (212) 873-7507.

The Education Department is sponsoring appearances by two da companies in the Museum auc rium. Both performances will be to those who have paid the daily seum entrance fee. On April 2 2:00 P.M., members of the **Phi** **pine Dance Company,** directed Reynaldo G. Alejandro, will exh some of their repertory of 40 dar representing the different cultures legends of the Philippines. On the lowing day, April 3, also at 2 P.M., the **Allnations Dance C** **pany** will present "Joy in Ev Land." This company of young fessionals of many nationalities forms dances representative of t respective cultures.

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by Stephen P. M

Let There Be Darkness

Optical observatories around the world need protection from increasing light pollution

In recent years, astronomers have become more and more concerned over the growth in light pollution—the presence in the environment of unnecessary artificial light that interferes with astronomical research. Light pollution has damaged the viewing conditions at some important observatory sites in the United States and abroad and has forced the relocation of others. National and international astronomy organizations have formed committees and task forces to investigate the problem. But until lately, few persons other than astronomers have worried about this effect, which the *New York Times* called ''light blight'' and ''a new and insidious form of environmental contamination.'' Since 1972, however, a growing awareness among community leaders and environmentalists, as well as concerned scientists, has stimulated the adoption of legal protection for several observatories, through ordinances that place limits on the design and operation of outdoor lighting equipment in urban areas. Recent evidence now suggests that such controls are actually working.

In the United States, the principal observatories with large telescopes are concentrated in the western states, which have experienced intensive economic development and population growth in the near past. The increase in light pollution around western cities has thus had a particularly serious effect on astronomy. At Lick Observatory, on Mount Hamilton near San Jose, California, a place that was described in 1887 as offering ''advantages superior to those found at any point where a permanent observatory has been established,'' lights and smog from the Bay Area are menacing the research program. Light and smog combine synergistically—smog particles reflect light in all directions, increasing the undesirable illumination of the night sky. In this way, air pollution also contributes to light pollution. A leading astronomer at Lick, Robert Kraft, has warned that by the 1980s, scientists there will no longer be able to observe extremely faint objects, such as the more distant galaxies and quasars.

In the mid-1960s, the problem at Lick was recognized, and a staff astronomer ran a two-year survey of California south of San Francisco in a search for a new and darker observatory location. (Locations farther north are considered less desirable for astronomical research because of more frequent spells of cloudy weather and diminished capability for viewing southern stars.) Charting California cities and their estimated sky glows, he found that much of southern California was already contaminated by light pollution. He projected an even worse situation for 1985, but by the early 1970s some astronomers had already concluded that this projection had erred on the optimistic side.

The problem is not confined to California, although that state, with Lick imperiled, Mount Wilson Observatory seriously disturbed by the lights of Los Angeles, and Mount Palomar Observatory menaced by the glow from both San Diego and Los Angeles, clearly is a leader in this unhappy trend. Throughout the country and, indeed, the world, astronomers are upset by the increased interference of outdoor lighting with delicate observations. In Mexico, city lights and pollution have twice forced the relocation of the principal research activities of the Observatorio Astronomico Nacional since 1951. The first move was from Tacubaya,
where skies were ruined by the
of Mexico City, to Tonanzintla
the growth of the city of Puebla
affected this site, too, and in 196
Mexican astronomers began dev
ing a new observatory in the
San Pedro Mártir, in Baja Calif
According to satellite photos of
cover conditions around the w
this is one of the three clearest
tions on earth. It is hoped that
rounding large forest and prote
legislation will retard light poll
at this ideal spot. If they don't,
may be no place left for astrono
to go.

Amateur astronomers report
lar problems. One amateur in
ford, Cheshire, in England, wro
the *Journal of the British A*
nomical Association to com
about new streetlights near his
and the installation of floodlight
nearby soccer stadium. He urge
low members of the associatio
protest to their respective membe
Parliament and noted that
streetlights had previously
turned off at midnight, now that
is in short supply they have the
on all night and sometimes d
daylight hours as well.'' An
amateur, of the aptly named Ch
Valley Astronomical Societ
Ohio, sells bumper stickers that
''I Would Rather See Starlight
Streetlights.''

In Japan, astronomers publis
brochure a few years ago, en
Please Protect the Observa
which warned that a principal
ing facility dedicated in 1955, i
dangered by the increased lighti
adjacent areas. Sketches in the
chure propose better shielding
outdoor lamps, and a chart indi
the danger zone where the
serious interference originates.
occasion, direct action has
taken. For example, in October
(according to the Associated Pr
the Japanese Environmental Age

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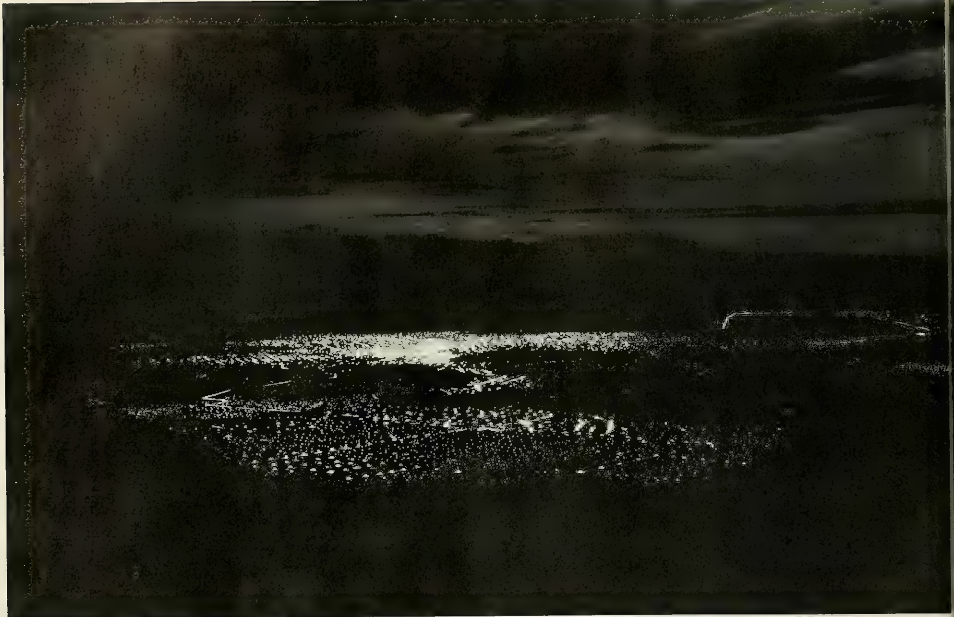
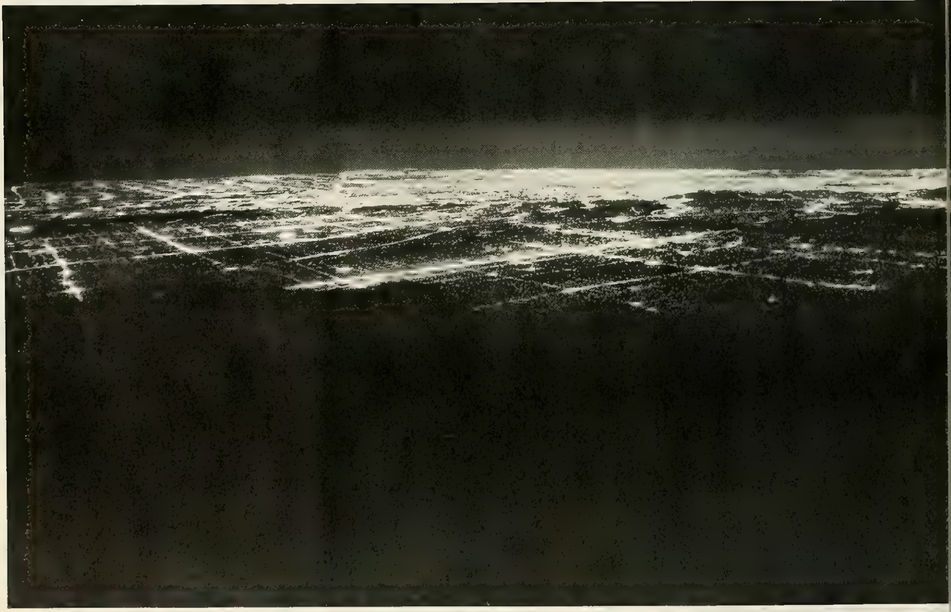


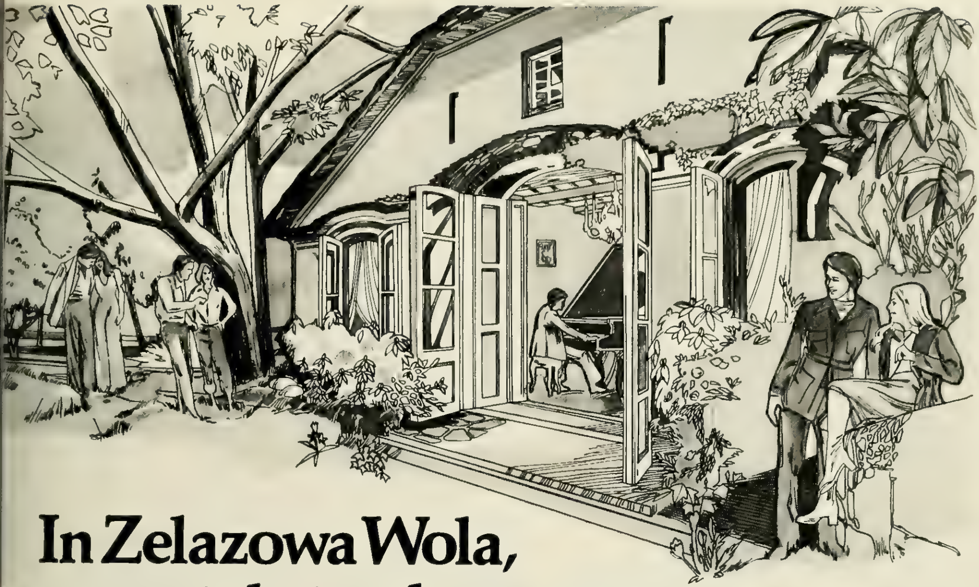
Kurt W Riegel Printed courtesy of *Science*



Worsening of the problem of light pollution can be seen in these two photographs of Greater Los Angeles. The top picture was taken from Mount Wilson in 1911; the bottom one in 1965. In view of the region's population growth, there is no reason to believe the situation has recently improved.

prompted by the Japan Association to Protect the Starry Sky, asked building owners to turn off lights in order to permit sky watchers to view a meteor shower associated with the breakup of Comet Giacobini-Zinner.

Jesuit astronomers at Castel Gandolfo, Italy, where the Vatican Observatory is located, built a portable ''night sky photometer,'' calib by the dim light of a radioactive sule. With this, they measure light pollution at various places i country. One of the most affecte cations turned out to be that o observatory itself, where the Je found that the sky brightness altitude of 45° above the horizo



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OLAND, a land of never-ending fascination

the direction of Rome, was more than 600 percent brighter than can be accounted for by the natural light of the stars and the earth's atmosphere. At the relatively unspoiled location of the island of Ponza in the Tyrrhenian Sea, by contrast, the undesirable illumination amounts to only 20 percent.

In the battle against light pollution, astronomers have, at times, despaired that things might only get worse. For example, at Wesleyan University in Middletown, Connecticut, the school administration installed four 100,000-candlepower mercury lamps adjacent to a protesting astronomy professor's 24-inch telescope. Bart J. Bok, an astronomer for more than 40 years, has told how, as director of the Mount Stromlo Observatory in Australia, he was forced by increased street lighting in Canberra to transfer much of the observatory's research program to a remote post in the outback. Bok had been present at Tonanzintla, when lights spoiled the sky over that part of Mexico. Now living in Tucson, where he has been director of Steward Observatory and is currently professor emeritus at the University of Arizona, he has watched outdoor lighting grow to the point where it threatened the world's finest collection of "big eyes."

The total investment in the astronomical laboratories of the Tucson area has been estimated at sixty million dollars, and more equipment is under construction. Within sixty miles of Tucson are the telescopes of the Steward Observatory, Kitt Peak National Observatory, the Lunar and Planetary Laboratory, the Mount Hopkins Observatory of the Smithsonian Institution, and the new McGraw-Hill Observatory. These are major installations. It was at Steward that the flashing light pulses from the Crab Nebula were discovered, and where astronomers identified several of the most distant quasars in the known universe. At McGraw-Hill, observers detected the optical outburst of nova A0620-00 (*see* "Exploding Stars," *Natural History,* May 1976). Kitt Peak was established in the late 1950s by the National Science Foundation to provide scientists and students from universities lacking modern instruments with access to such facilities at a good viewing location. By the early 1970s, however, Bok and other local scientists reported that growth in the number and intensity of outdoor lights in Tucson and Phoenix, as well as in outlying trailer parks and small towns on the desert, threatened Kitt Peak and the other nearby observatories. Even the vehicular headlights from the increased flow of traffic on Interstate 10 between Tucson and Phoenix contributed to the problem.

In June 1972, the astronomers persuaded Tucson authorities to adopt ordinance No. 3840, dealing with outdoor lighting, a landmark in the fight against light pollution in major urban areas. This ordinance directed that future lighting installations be fully shielded so the lights would shine down, not up, and that they be filtered, if necessary, to remove the bluer shades that interfere most with astronomy. Relatively inoffensive home-lighting installations were not affected. Advertising searchlights were to be turned off between midnight and sunrise and outdoor illumination of buildings "by floodlight projected above the horizontal" was banned when the purpose was purely architectural or esthetic. Some types of advertising lights were also restricted. At both Kitt Peak and the University of Arizona, astronomers promoted compliance with the new rule by counseling local businessmen on acceptable lighting designs and by writing to national manufacturers to encourage the design of less offensive streetlight reflectors.

Heartened by the Tucson ordinance, astronomers in Richland, Washington, the site of the Battelle Institute's observatory, persuaded the city fathers to enact a similar law. But not all astronomers are optimistic. One outspoken activist in San Diego contributed an editorial to the astronomical journal *Mercury* entitled "Can We Save What's Left of the Dark?" warning that the end of optical astronomy in the United States may be inevitable.

In a society already concerned about energy conservation, light pollution is a cause of dismay not only to astronomers. Light that streams out into the sky is wasted, performing no useful purpose. It represents a substantial loss of electrical energy, much of which is generated by burning precious reserves of fossil fuels. Surely commonsense approaches can be found to this problem. When Smithsonian astronomers at Mount Hopkins, for instance, complained about bright new lights at the dog track in Amado, Arizona, the management installed better reflectors on the lamps, resulting in both a brighter track and less stray light in th
The latter was appreciated by
omy researchers and the form
welcomed by local students o
and improvers of the grey
breed.

Much of the lighting in
areas, notably that using new
bright mercury and sodium
lamps, has been justified c
ground that it will discourage
Bright streetlights may provide
tional reassurance to appreh
pedestrians, but there is little
that they actually prevent crim
cording to a published study
UCLA astronomer who com
FBI crime figures with data o
door lighting.

Fortunately, a happy ending
be in sight. A principal author
light-pollution measurements,
A. Hoag of Kitt Peak, repor
April 1976 that his data (as rec
at Kitt since 1970) show tha
Tucson ordinance No. 3840
adopted in 1972, the rate of in
in light pollution dropped off dr
cally. Further, at the Univers
Hawaii, which has a major ne
servatory under developmer
Mauna Kea, the director of the
tute for Astronomy told me of su
in obtaining legal protection
countywide basis even *before*
pollution reached threatening pr
tions. There, light pollution wa
ceived as an environmental iss
general concern, rather than a
noyance only to cloistered scie
Civic leaders got together to boc
protective measures suggested l
Mauna Kea astronomers and the
olulu Advertiser lent editorial
port, which concluded that "lig
controls on the Big Island would
keep the mountaintop valuable
nomically to the benefit of Hawa
the rest of the world."

In addition to interfering wit
tronomical research, light poll
creates a more subtle, less quan
ble loss that affects everyone:
prives urban dwellers of the opp
nity to witness and enjoy the
beauty of the night sky. The r
work of Hoag, which shows t
light-pollution ordinance can ac
its purpose, and the increased in
by municipal governments in
issue suggest that we may yet se
"dark at the end of the tunnel.'

Stephen P. Maran is an astron
at NASA's Goddard Space
Center in Greenbelt, Maryland.

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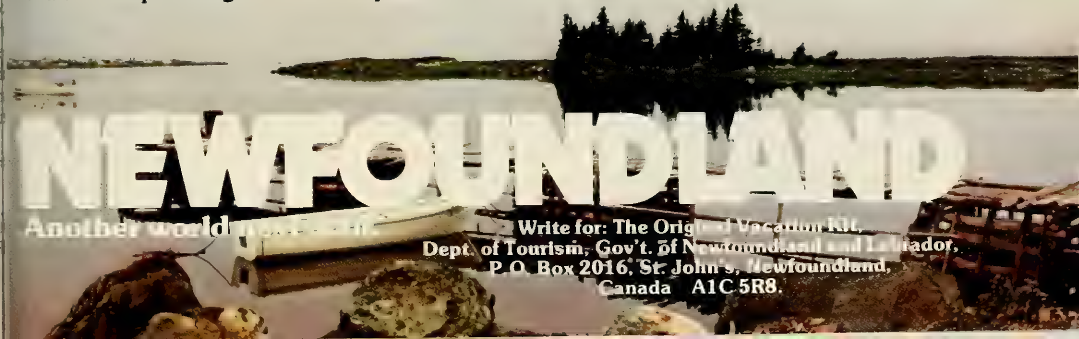

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hree books on epidemics have ap- ed in short succession. If their au- s had previously agreed to avoid petition, they could scarcely : done better, for they have ap- ched their subject in radically rent ways. William H. McNeill, of this country's most noted his- ns, professor of history at the versity of Chicago, and author of much acclaimed *The Rise of the t: A History of the Human Com- ity,* has given us another master- e. His *Plagues and Peoples* was lled from a vast amount of re- ch; it deals with the origins of epi- ic disease and traces its role in ian affairs throughout the ages. ed W. Crosby, Jr., associate pro- or of history at Washington State versity, is also not a newcomer. ıas earlier dealt with the biologi- consequences of Christopher Co- bus's adventures in *The Colum- Exchange,* and his new book, *Epidemic and Peace, 1918,* takes a single, recent epidemic and studies it in depth, with emphasis on its human impact. The third book, *Epidemics,* is essentially a short sourcebook with selected quotations from original texts. Geoffrey Marks is a medical writer and William K. Beatty is professor of medical bibliography.

The most ambitious design is obviously McNeill's. Only a seasoned historian would have dared take such a long view of life on this planet. How did infectious disease come about? How did it affect the early hunters? What did civilization and infectious disease do to each other in different parts of the world? What is the impact of climate on local parasites and thereby on local culture? What was the role of travel? And of medicine? Others have tackled such questions, notably Hans Zinsser in his memorable *Rats, Lice and History,* but McNeill's book will remain the landmark for years to come.

I had long waited for someone who would tell me what people, plants, and microbes meant to each other over the ages; this is the closest I can hope to get. McNeill works at the giant puzzle with a broad grasp of matters historical, as one would expect, but he has also done his scientific homework exceptionally well (witness the fifty-four pages of notes)

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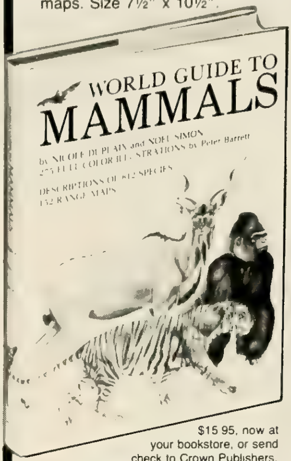

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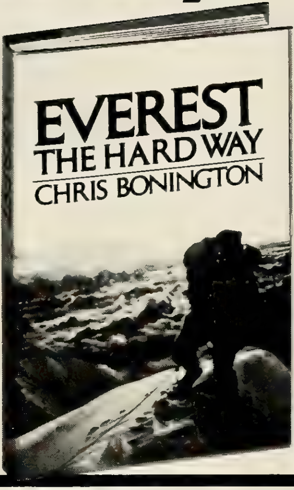

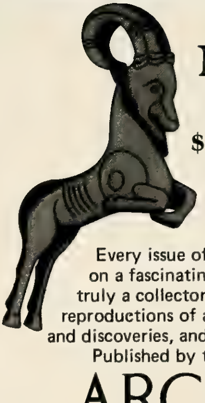

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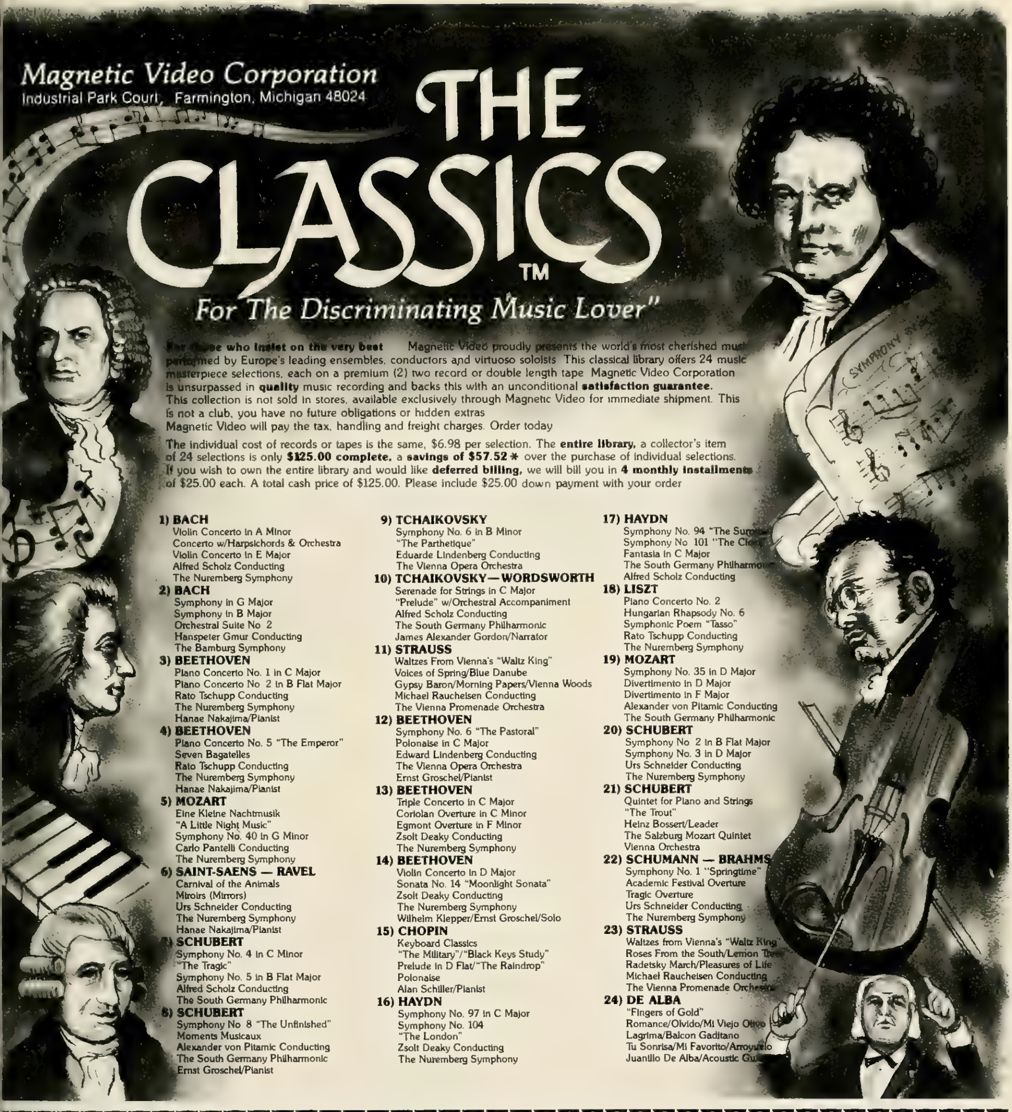
and uses medical lingo so accur that I suspected him of having a couple of years in medical sc But he modestly credits nin readers and a few other experts combed through the manuscript

I cannot convey the sweep of a book in a few lines, but I can you an example of McNeill's spective. He deals with our para as inhabitants of the world with impartiality that mankind somet sounds like a minority group (he it humankind). In fact he mad think that a Martian visitor, loc at our planet with keen eyes, n conclude that its real inhabitant the bacteria (which are obvi more numerous and more w spread) and interpret the people disease that tends to destroy greenery, pollute the air and w and cause the growth of ma tumors called cities. If you never thought of yourself as a ease, let me give you this food thought in McNeill's own w "Looked at from the point of vie other organisms, humankind t fore resembles an acute epidemic ease, whose *occasional lapses less virulent forms of behavior* [it mine] have never yet sufficed to mit any really stable, chronic tionship to establish itself." In words, the world is still acutely fering from us.

Among the many themes de oped by McNeill, I will choose a to stimulate your appetite for m Civilization, as we all kn crowded people into cities, and provided big game for bacteria. known is that many epidemic eases of civilization began thei reers among "cattle crowds herds—and then transferred from tle to man. On the American c nent, animals domesticable on a l scale were not available (remem there were no horses, no cows sheep before the Europeans ca This may help us understand how Aztecs could pile up in cities as l as Tenochtitlán (Mexico City) an remain free of the diseases of ci zation that ravaged the Old Worl the long run, of course, this was to their advantage: it deprived t of the chance to develop bact strains with which to mow dow invading Spaniards.

That America was conquered by bacteria and viruses than by w ons is too well known to repeat McNeill chooses examples that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The South Germany Philharmo
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18) LISZT
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Rato Tschupp Conducting
The Nuremberg Symphony

19) MOZART
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Divertimento in D Major
Divertimento in F Major
Alexander von Pitamic Conducting
The South Germany Philharmonic

20) SCHUBERT
Symphony No 2 in B Flat Major
Symphony No. 3 in D Major
Urs Schneider Conducting
The Nuremberg Symphony

21) SCHUBERT
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Heinz Bossert/Leader
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Vienna Orchestra

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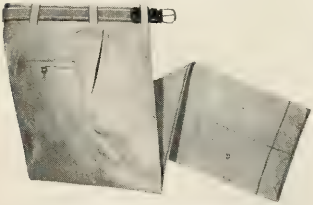

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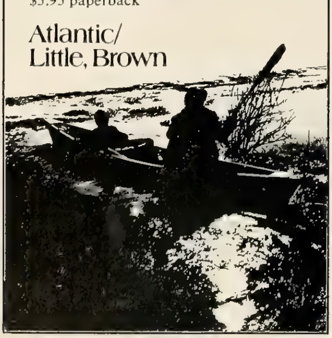

give you the chills (and make you feel even more guilty toward your American Indian friends). Such as the tale of the Cayapo, a South American tribe, which numbered 6,000 to 8,000 in 1903. That year the tribe accepted one single missionary who made every effort to preserve the Cayapo from the dangers of civilization. Result: In 1918 they had dropped to 500; in 1950, only two or three were left. The tribe disappeared. And this time the intentions had been the best.

Three-way interactions (plants–people–parasites) show even more clearly how man the manipulator can be manipulated by his own doings. In Europe, during the 1600s, improved agricultural methods provided turnips and alfalfa as feed for cattle on a scale previously impossible. This meant more cattle for food, thus more healthy people; but it also meant a better target for the malaria-carrying mosquito, which prefers cattle to people. Now it so happens that the malarial parasite does not find cattle a suitable host; so the chain of infestation was broken, and malaria withdrew to the Mediterranean lands, where summer droughts prevented the production of the new fodder crops.

The effects of world travel provide McNeill with more nuggets. In the days of sailing ships, for instance, the plague had time to burn itself out during long trips: an automatic quarantine, in a way. When ships became bigger and faster and could carry larger populations of rats, the plague bacilli managed to cross the oceans successfully. What better illustration of the two-edged sword of progress. But the most fascinating tale about the plague is the step-by-step expansion of *Pasteurella pestis*, hitching rides as it could from the Himalayan foothills until centuries later it found a perfect microclimate in rodent burrows of the New World all the way from Mexico to Canada. Get bitten today by a ground squirrel in the western United States and you stand a fair chance of coming down with good old-fashioned bubonic plague. We are now armed against it with streptomycin and other magic bullets, but the bugs have not given up since the Middle Ages—they have just gone underground.

Now be prepared for a shock. Did it ever occur to you that bugs and taxes might have something in common? This is one of McNeill's most original thoughts. He brings it
discussing the situation of far
whose energies—historically—
been drained either by di
("microparasitism") or by
("macroparasitism"). It took
little while to accept this notion.
it both interesting and awk
Also, I have a hunch that som
fessional historian will try to
to shreds. It is certainly true tha
microparasitism and macropara
can sap your blood, but time w
whether the idea of considering
on the same plane is a stroke of g
or a play on words. And talking
words: infectious diseases (n
parasitism) make you immune.
the Latin word *immunis* meant
empt from taxes" (macroparasit
So there is a true bridge of lan
between microbial and fiscal
sites. McNeill does not use this
ment, but I think it adds power
cause.

In a book dealing with epide
it is somewhat sobering for a p
cian to find that medicine is first
tioned on page 235. The reason
vious. Before Pasteur (and unt
late 1800s) there was no effectiv
to deal with infectious disease, e
for smallpox vaccination, whic
launched about 1800, and sma
inoculation, which was prac
sporadically on a smaller scale i
lier centuries.

In summary, a great book. (I
its publishers would read it,
notes included. Perhaps next
they would make it a little easi
the reader to find the notes. Boo
signers seem to forget that b
once they are sold, also have
read.)

Crosby's *Epidemics and P*
1918, is a fine, galloping accou
the influenza pandemic that
some 25 million people in less
a year. In some ways it was a
out of the Middle Ages bound in
twentieth century. No plague
killed so many people in so sh
time. And there was no treatme
all, except TLC (tender loving c
nurses were better at it than doc
Crosby chooses some ghastly
sodes that you will never forget
the tale of whole Alaskan vil
wiped out, except for the dogs g
ing at the dead with live childre
huddled against them. Or the h
trip of the *Leviathan*, boun
Europe packed with troops—a
explosion of influenza on b
Other episodes are gripping be

emind us that the survival of on sense under stress, in our sedly rational society, is not to en for granted. San Francisco, stance, became bitterly divided he issue of wearing prophylac- ıze masks. Eventually the po- ecame involved. In retrospect, nsense seems almost hilarious, t that the sensible messages lrowned out. It could all happen

: final chapter, on the discovery : virus, reads like science fic- And in the end, having told the f 25 million deaths, Crosby is ed by a problem of human mem- This enormous, worldwide dis- made very little impact on the ors. There is practically no of it in literature (compared with cient plagues that killed fewer e) and it is scarcely remembered

part, I am sure, this was an effect orld War II, which blurred the episode (although the war it- illed less people). But this is bly not the main reason. A dis- hat affects everybody but kills 2 or 3 percent is not terribly ening. People tend to accept it gamble, almost as a challenge. lague is quite another story: its lity can approach 100 percent. flu could not produce a lasting . But it did produce a sensitive, ugh, well-written book.

e third book, *Epidemics,* by s and Beatty, does not aspire to the same league as the other It is essentially a short textbook a short bibliography; its basic is to provide you with excerpts erature from all times. An eye- ss account is more impressive statistics, as when a survivor of lack Death complains that the l has become a lonely place.

hy three books about epidemics, nay wonder? Why all at once? y be coincidence, but I prefer to it as a sign of renewed interest ıe physical world around us. e little creatures could do us in ı any time—or they could help us ve on this planet. History, as as science, can teach us how to vith them.

o Majno is chairman of the rtment of Pathology at the Uni- ty of Massachusetts Medical ol. He is also the author of The ing Hand: Man and Wound in ncient World.

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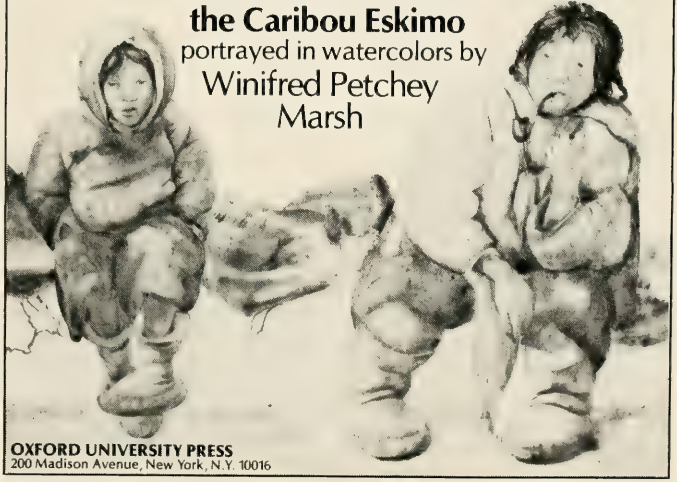

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Additional Reading

Hot Spots (p. 36)

Walter Sullivan's *Continents in Motion* (New York: McGraw-Hill Book Company, 1974) provides one of the best general accounts of the complex processes involved in plate tectonics. "Hot Spots on the Earth's Surface," by Kevin C. Burke and J. Tuzo Wilson (*Scientific American*, August 1976, pp. 46–57), gives additional details of the surface manifestations and worldwide distribution of volcanic hot spots. Harold T. Stearns's textbook, *Geology of the State of Hawaii* (Palo Alto: Pacific Books, 1966), provides a descriptive account of volcanic activity at the world's most prolific hot spot. For more technical studies of hot spot activity see W. Jason Morgan's "Deep Mantle Convection Plumes and Plate Motions" (*American Association of Petroleum Geologists Bulletin*, 1972, vol. 56, pp. 203–13) and Peter R. Vogt's "Evidence for Global Synchronism in Mantle Plume Convection, and Possible Significance for Geology" (*Nature*, 1972, vol. 240, pp. 338–42). David A. Ross's "The Red Sea: An Ocean in the Making" (*Natural History*, August–September 1976, pp. 74–77) adds another perspective to the understanding of mantle–surface interactions.

Aztec Cannibalism (p. 46)

For details of the evidence upon which his theory is based, see Michael Harner's lengthy paper in the February 1977 issue of *American Ethnologist:* "The Ecological Basis for Aztec Sacrifice." In his account for *Natural History*, Harner quotes from *The Conquest of New Spain*, by Bernal Díaz del Castillo (trans. by John M. Cohen, New York: Penguin Books, 1963, $2.50). Bernal Díaz, the most famous participant-chronicler of the conquest of Mexico, provided comprehensive accounts of Aztec sacrifices and their aftermath. Two of the more popular accounts of Aztec life-styles at the time of the conquest stand in stark contrast to Díaz's, each devoting a single sentence of text to the issue of cannibalism. One is William H. Prescott's
The Conquest of Mexico, a
volume written in the
nineteenth century and now ava
bound together with his *The*
quest of Peru (New York: Mode
brary, $5.95). The other is fro
1940s, George C. Vaillant's *A*
of Mexico: Origin, Rise, and F
the Aztec Nation (rev. ed. by S
nah B. Vaillant, New York: Pe
Books, $2.95). Jacques Sous
Daily Life of the Aztecs on th
of the Spanish Conquest (Sta
Stanford University Press,
$2.95), although written in a po
style, is generally authoritativ
informative.

Mud Turtles (p. 52)

Archie Carr's *So Excelle*
Fishe: A Natural History o
Turtles (New York: Doubleda
tural History Press, 1973, $2.95
vides a thorough, comparative u
standing of turtle behavior and
ogy—patterns of movement a
production, nest construction, e
of predation, and the impa
human activities are well co
Turtles of the United States, b
petologists Carl H. Ernst and
W. Barbour (Lexington: Univ
of Kentucky Press, 1972), is a
prehensive, detailed (3 to 4 pag
species) volume providing colo
tographs and general informati
habitat, range, behavior, and bi
of turtles. John Goode's *Turtles*
toises, and Terrapins (New
Charles Scribner's Sons,
$4.95) is a good general referen
the layman. More precise inf
tion on the ecology and activit
yellow mud turtles can be fou
I.Y. Mahmoud's studies: "Cou
Behavior and Sexual Maturity in
Species of Kinosternid Tu
(*Copeia*, 1967, pp. 314–19)
"The Comparative Ecology o
Kinosternid Turtles of Oklah
(*Southwestern Naturalist*, 1969
14, pp. 31–66).

Antlions (p. 64)

William Morton Whee
Demons of the Dust (New Yor
W. Norton & Company, 1930

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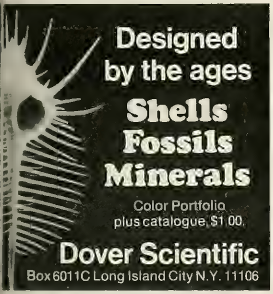
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classic account of the biology and behavior of antlions and other predacious insects found in desert habitats. *Animal Architecture*, by Karl and Otto von Frisch (New York: Harcourt Brace Jovanovich, 1974, $12.95), and *Ancient Artizans*, by Stuart W. Frost (Boston: Van Press, 1936), are books on how and why animals modify their habitat or build structures to meet their needs. Other studies of antlion excavations are "Pit Construction by Myrmeleontid Larvae," by G. Youthed and V. Moran (*Journal of Insect Physiology*, 1969, vol. 15, pp. 867–75), and "Mechanisms of Pit Construction by Antlion Larvae," by Razvan Tuculescu et al. (*Annals of the Entomological Society of America*, 1975, vol. 68, pp. 719–20).

Coral Reefs (p. 72)

Douglas Faulkner's *The Living Reef* (New York: Quadrangle, 1974) and Jacques Cousteau and Philippe Diole's *Life and Death in a Coral Sea* (Garden City: Doubleday, 1971) are beautifully illustrated introductions to the world's coral reefs. F. G. Smith's *Atlantic Reef Corals* (rev. ed. Miami: University of Miami Press, 1971, $6.95) and T. F. Goreau's "Ecology of Jamaican Coral Reefs" (*Ecology*, 1959, vol. 40, pp. 67–89) introduce reefs of the Atlantic Ocean. "Life and Death of the Reef," by Robert E. Johannes, with stunning photographs by Douglas Faulkner (*Audubon*, September 1976, pp. 36–55), is a graphic account of the impact of man's activities on coral biology. This article is followed by Kenneth Brower and Douglas Faulkner's "To Tempt a Pacific Eden, One Large Oily Apple" (pp. 56–91), spelling out plans to turn a group of Pacific coral reefs into a superport-oil refinery complex. The responses of coral organisms to damage and pollution are described in two earlier *Natural History* articles: Gilbert L. Voss's "Sickness and Death in Florida's Coral Reefs" (August–September 1973, pp. 40–47) and Ralph Mitchell and Hugh Ducklow's "Slow Death of Coral Reefs" (October 1976, pp. 106–110).

Gordon Beckhorn

Erratum:
In the photograph on page 66 of the February 1977 issue, the fish labeled a rosyside dace is actually a redline darter.

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Incorporating Nature Magazine
Vol. LXXXVI, No. 5
May 1977

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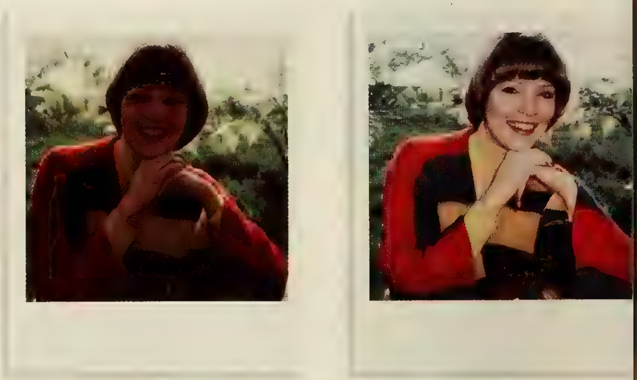

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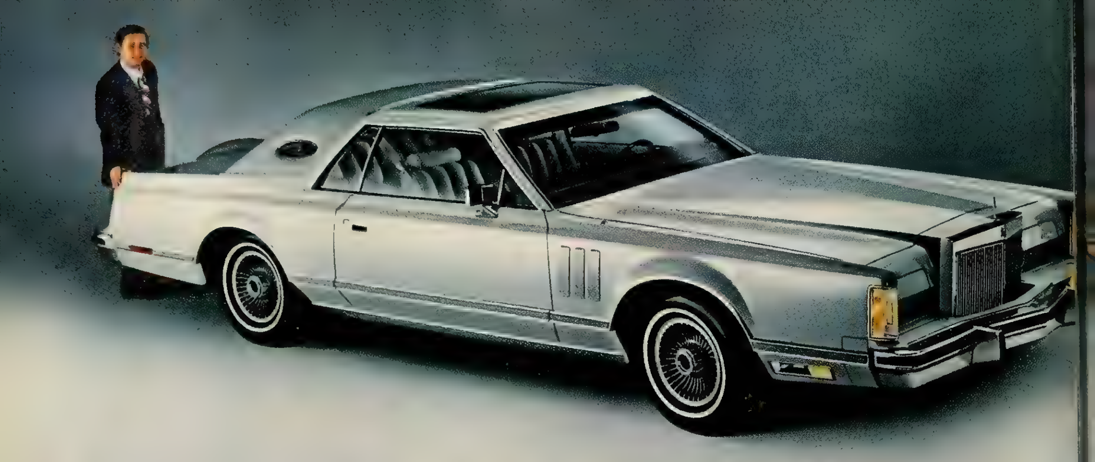

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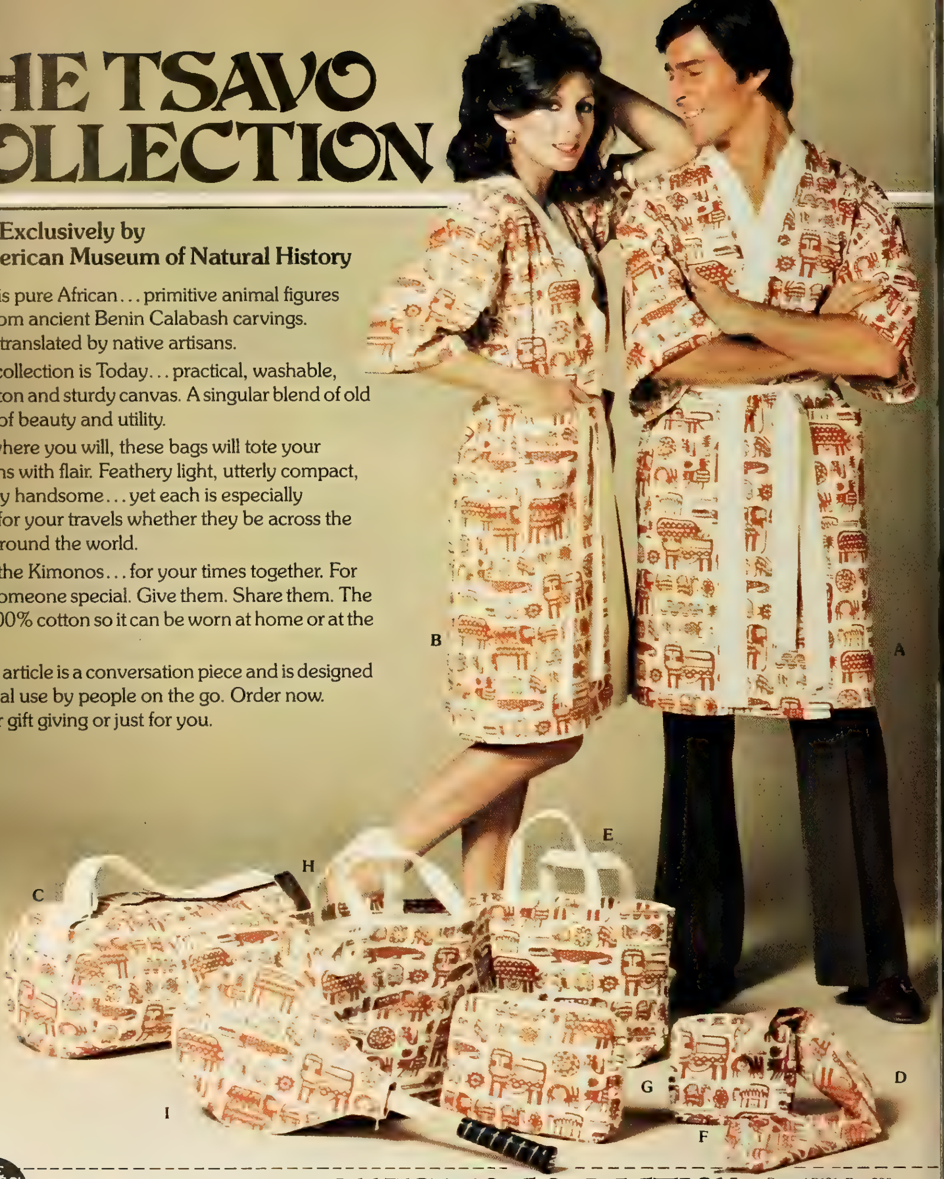

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oger L. Welsch first learned ıt folk architecture ten years ago raduate school and says he has ı preoccupied with its varieties, cially on the Great Plains, ever e. Currently a professor of folk- at the University of Nebraska, sch would like to spend less time ying traditional buildings and e time "thinking about them, feeling them, building them, tearing them down, driving nails, and cussing." In this effort, he is reconstructing two log cabins on his Nebraska farm. So attuned to nineteenth-century life on the plains is Welsch that he says he would like to look like C. N. Dunlap, a ranch foreman during the 1880s, whose photograph appears here.

While still in high school, **Klaus-Friedrich Koch** walked across Sardinia and Montenegro and his later travels have taken him to unexplored parts of New Guinea (where he lived for nearly two years in a remote valley in the Central Mountains), to the Himalayan kingdom of Bhutan before the Lindblads got there, and through Burma and Afghanistan. He has also been to Tahiti, Samoa, Fiji, and Tuvalu (formerly Ellice Islands). In 1974, he made a pilgrimage to Mecca and in 1976 he felt a sudden need to visit Timbuktu. Koch camouflages his addiction to traveling by conducting ethnographic research. He taught anthropology at Harvard for several years before joining the faculty of Northwestern University. His many publications include two previous articles in *Natural History*.

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Evolution's Erratic Pace

The history of life contains "long periods of boredom and short periods of terror "

On November 23, 1859, the day before his revolutionary book hit the stands, Charles Darwin received an extraordinary letter from his friend Thomas Henry Huxley. It offered warm support in the coming conflict, even the supreme sacrifice: "I am prepared to go to the stake, if requisite . . . I am sharpening up my claws and beak in readiness." But it also contained a warning: "You have loaded yourself with an unnecessary difficulty in adopting *Natura non facit saltum* so unreservedly."

The Latin phrase, usually attributed to Linnaeus, states that "nature does not make leaps." Darwin was a strict adherent to this ancient motto. As a disciple of Charles Lyell, the apostle of gradualism in geology, Darwin portrayed evolution as a stately and orderly process, working at a speed so slow that no person could hope to observe it in a lifetime. Ancestors and descendants, Darwin argued, must be connected by "infinitely numerous transitional links" forming "the finest graduated steps." Only an immense span of time had permitted such a sluggish process to achieve so much.

Huxley felt that Darwin was digging a ditch for his own theory. Natural selection required no postulate about rates; it could operate just as well if evolution proceeded at a rapid pace. The road ahead was rocky enough; why harness the theory of natural selection to an assumption both unnecessary and probably false? The fossil record offered no support for gradual change: whole faunas had been wiped out during disarmingly short intervals (see my column of October 1974). New species almost always appeared suddenly in the fossil record with no intermediate links to ancestors in older rocks of the same region. Evolution, Huxley believed, could proceed so rapidly that the slow and imperfect process of sedimentation rarely caught it in the act.

The conflict between adherents of rapid and those of gradual change had been particularly intense in geologic circles during the years of Darwin's apprenticeship in science. I do not know why Darwin chose to follow Lyell and the gradualists so strictly, but I am certain of one thing: preference for one view or the other had nothing to do with superior perception of empirical information. On this question, nature spoke (and continues to speak) ambiguously and multifariously. Cultural and methodological preferences had as much influence upon any decision as the actual data.

On issues so fundamental as a general philosophy of change, science and society usually work hand in hand. The static systems of European monarchies won support from legions of scholars as the embodiment of natural law. Alexander Pope wrote:

> Order is Heaven's first law;
>   and this confessed,
> Some are, and must be,
>   greater than the rest.

As monarchies fell and as the l
eighteenth century became embroi
in an age of revolution, scient
began to see change as a normal p
of universal order, not as aberrant a
exceptional. Scholars then tra
ferred to nature the liberal program
slow and orderly change that they
vocated for social transformation
human society. Karl Marx rec
nized the primary path of influe
when he wrote to Engels in 1862:

> It is remarkable how Darwin recogni
> among beasts and plants his English s
> ety with its division of labor, comp
> tion, opening up of new market, "inv
> tion," and the Malthusian "struggle
> existence."

To many scientists, natural ca
clysm seemed as threatening as
reign of terror that had taken th
great colleague Lavoisier.

Yet the geologic record seeme
provide as much evidence for ca
clysmic as for gradual change. The
fore, in defending gradualism a
nearly universal tempo, Darwin h
to use Lyell's most characteri
method of argument—he had to re
literal appearance and common se
for an underlying "reality." (C
trary to popular myths, Darwin a
Lyell were not the heros of t
science, defending objectiv
against the theological fantasies
such "catastrophists" as Cuvier a
Buckland. Catastrophists were
committed to science as any gradu
ist; in fact, they adopted the m
"objective" view that one should
lieve what one sees and not inter

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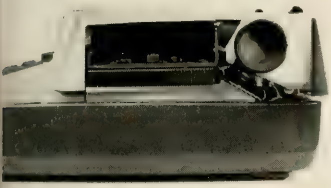

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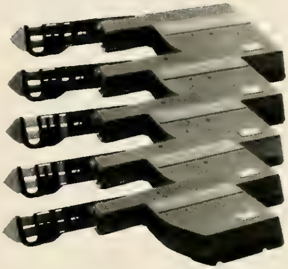

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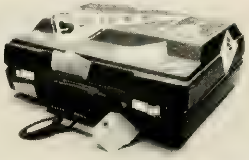

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vorable mutations are diluted by the sheer bulk of the population through which they must spread. They may build slowly in frequency, but changing environments usually alter their value before they reach fixation. Thus, phyletic transformation in large populations should be very rare—as the fossil record proclaims.

But a species on the periphery is isolated, even cut off from its parental stock. It lives as a tiny population in a geographic corner of the ancestral range. Selective pressures are usually intense because peripheries mark the edge of ecological tolerance for ancestral forms. Favorable variations spread quickly. Small, peripheral isolates are the laboratory of evolutionary change.

What should the fossil record include if most evolution involves the speciation of peripheral isolates? Species should be static through their range because our fossils are the products of large central populations. In any local area inhabited by ancestors, a descendant species should appear suddenly by migration from the peripheral region in which it evolved. In the peripheral region itself, we might find direct evidence of speciation, but such good fortune would be rare indeed because the event occurs so rapidly in such a small population. Thus, the fossil record is a faithful rendering of what evolutionary theory predicts, not a pitiful vestige of a once bountiful tale.

Eldredge and I refer to this scheme as the model of punctuated equilibria. Lineages change little during most of their history, but events of rapid speciation occasionally punctuate this tranquillity. Evolution is the differential survival and deployment of these punctuations. Our model is fully consistent with Darwin's central postulate that natural selection controls evolutionary change. Natural selection requires continuity and intermediacy, for selection must create the fit by steadily increasing the frequency of favorable variants. It does not require exceedingly slow and gradual transformation of entire populations. (In describing the speciation of peripheral isolates as very rapid, I speak as a geologist. The process may take hundreds, even thousands of years; you might see nothing if you stared at bees on a tree for your entire lifetime. But a thousand years is only an instant in the three-billion-year recorded history of life. Geologic resolution is usually far more coarse.)

If gradualism is more a produc Western thought than a fact of natu then we should consider alternat philosophies of change to enlarge realm of constraining prejudices. the Soviet Union, for example, sci tists are trained with a very differ philosophy of change—the so-cal dialectical laws, reformulated Engels from Hegel's philosophy. T dialectical laws are explicitly punc ational. They speak, for example, the "transformation of quantity i quality." This may sound l mumbo jumbo, but it suggests t change occurs in large leaps follo ing a slow accumulation of stres that a system resists until it reac the breaking point. Heat water an eventually reaches a boiling poi Oppress the workers more and m and they suddenly break their chai Eldredge and I were fascinated learn that most Russian paleonto gists support a model very similar our punctuated equilibria. The c nection cannot be accidental.

I emphatically do not assert general "truth" of this philosophy punctuational change. Any attemp support the exclusive validity of s a grandiose notion would border the nonsensical. Gradualism so times works well. (I flew over folded Appalachians this morn and saw the striking parallel rid left standing by gradual erosion of softer rocks surrounding them. make a simple plea for pluralism guiding philosophies, and for recognition that such philosophi however hidden and unarticulat constrain all our thought. The dial tical laws express an ideology q openly; our Western preference gradualism does the same thing m subtly.

Nonetheless, I will confess t personal belief that a punctuatio view may prove to map tempos biological and geologic change m accurately and more often than any its competitors—if only beca complex systems in steady state both common and highly resistant change. As my colleague British ologist Derek V. Ager writes in s porting a punctuational view of g logic change: "The history of one part of the earth, like the life a soldier, consists of long periods boredom and short periods of terro

Stephen Jay Gould teaches biolo geology, and the history of scienc Harvard University.

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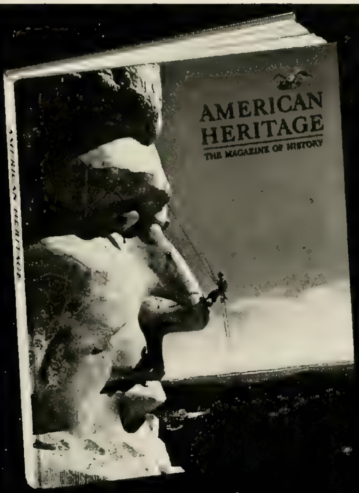

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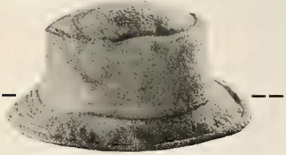

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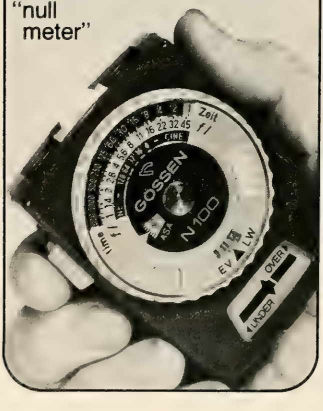

Letters

Aztec Enigma

Michael Harner's picture of the supposed contrast between the Old World and the New, and between Mexico and the Andes, is simply wrong ("The Enigma of Aztec Sacrifice," April 1977). Herbivores suitable for domestication were *never* eliminated from Mesoamerica, either by the "ancient hunters" or by environmental changes following the last glaciation. Deer, bighorn sheep, pronghorn antelope, tapirs, and peccaries, to mention only the larger herbivores of Mexico, could all have been successfully domesticated to assure a steady supply of animal protein. Any animal on the long list of Mexican relatives of the South American guinea pig would have done the job just as nicely for the ancient Mesoamericans as the guinea pig did for the Andean peoples. Sahagún refers to gopher meat tamales and to rats in a long inventory of high-status food for the well-nourished Aztec aristocracy. And what about the rabbit—like the guinea pig, a rodent—with its near-legendary fecundity and its soft hair that was so highly prized for warriors' costumes?

What makes the Mesoamericans unique is that they did not choose to domesticate animals that were available. They did domesticate the turkey, the dog, the honey bee (whose protein-rich larvae were also eaten), and possibly the duck. Harner is wrong to call the dog a "carnivore" and hence, not only an inefficient converter of protein but one that "competed with its breeders for animal protein." Dogs are omniverous, the Mexican hairless especially so, fattening readily on an almost wholly carbohydrate diet. Its average weight is 30 to 35 pounds.

Woodrow Borah's unpublished population estimate, cited by Harner, of 25 million for central Mexico, finds few takers among Mesoamericanists. We agree with Edward Calnek and H. B. Nicholson that the actual figure probably lies between 10 and 15 million at most. Nor have we been able to find anyone who would agree with the astonishing figure of 250,000 sacrificial victims per annum, which Harner, without citing any evidence, chooses to equate with 250,000 human bodies for the Aztec dinner table.

Harner did not mention the Aztec empire's tribute system, thanks to which enormous amounts of goods—including foodstuffs—and services flowed into the three cities of the Triple Alliance from conquered provinces. Sahagún claimed that thanks to annual tribute in maize, beans, and chia seeds, there were enough basic staples in the royal granarie sustain Tenochtitlán for twenty year

Harner's "materialist," or econo determinist, interpretation, has in e reduced the Indian ancestors of mo Mexicans and millions of Mexi Americans to the level of creatures s of their stomachs, too undiscernin recognize that there were other, far r efficient and economical ways of ge protein than eating their fellows. H Harner and the editors of *Natural His* considered the social and political in cations of disseminating such a me nistic view of Mexican prehistory journal that for hundreds of thousand its readers is the only source of anthr logical information?

PETER T. F
JILL LESLIE F
State University of New York, Al

One might object to many of the de adduced by Michael Harner in "The cret of Aztec Sacrifice." But he has vanced a hypothesis that fits what know about human nutrition and ce Mexican society of the late fifteenth early sixteenth centuries. His theory c plements the two other hypotheses (o population and a deliberate policy terror on the Aztecs' part) that have b advanced to explain the remarkable liferation of human sacrifice and a ciated ingestion of parts of the vic after the middle of the fifteenth cent Accordingly, Harner's ideas must taken seriously and tested by much ther research.

Harner's critics seem to place Saha and Durán in opposition to Bernal D I do not think that these sources really opposed. Bernal Díaz agrees with c Spaniards who were among the ear Europeans to arrive in central Mex For an elucidation of Sahagún and Du we should look to the *Relaciones* *gráficas,* a lengthy series of rep prepared for Philip II a half century the conquest, which used Indian elde informants and included description heathen rites and customs. These rep were roughly contemporaneous those of Sahagún and Durán but cov the entire country. Their testimony is tually unanimous that in aboriginal tin as now, there was an abundance of f for sale; the upper classes ate relati well and the lower classes poorly. cording to the reports, the diet of lower classes had improved substant under Spanish rule.

For the Valley of Mexico, we ha report on the city of Texcoco, across

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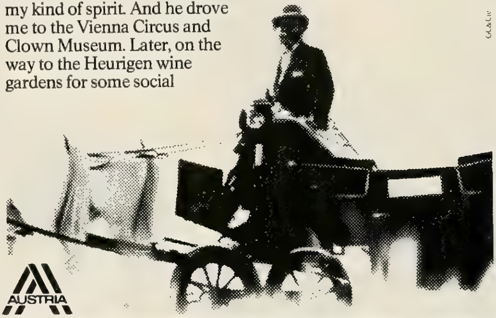

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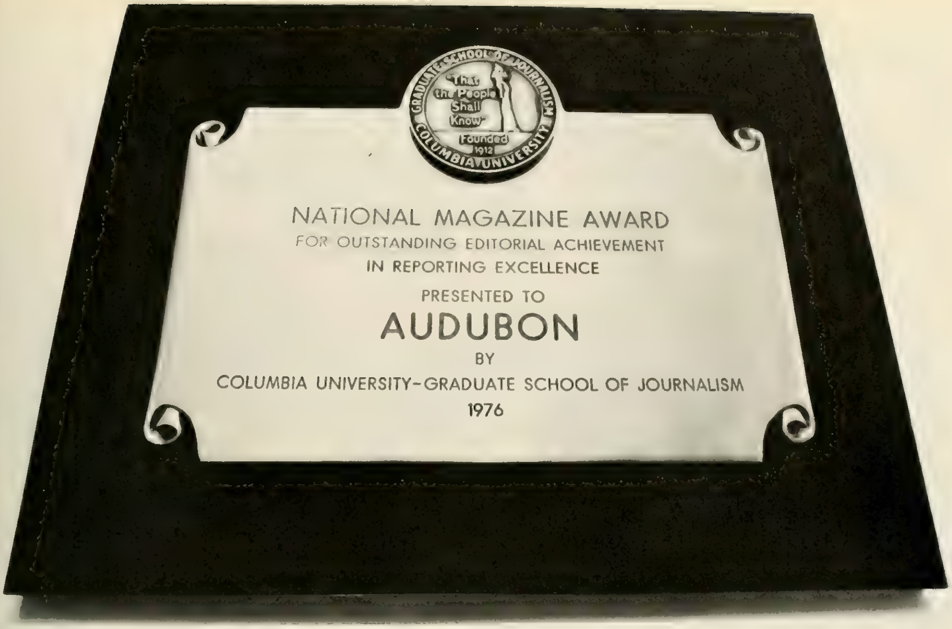
lake from Tenochtitlán. This report st
clearly that central Mexico's general
ation regarding food distribution alsc
plied to Texcoco, and almost certain
the rest of the Valley.

In 1974 the late Sherburne F. Cook
I read a paper on food production
nutrition in central Mexico at the Inte
tional Congress of Americanists in M
ico City. We devoted a paragraph to
nibalism as a source of animal prot
although by no means the sole one, in
aboriginal period. Our paper was reac
and circulated among, a consider
body of anthropologists and ethno
torians from many countries, incluc
Mexico. In a vigorous discussion, no
raised a question, much less an objecti
to our paragraph on cannibalism. I
pect that Harner's sin is that he has da
to raise in public what has long been
cussed in scholarly circles.

WOODROW BOR
University of California, Berk

THE AUTHOR REPLIES: The point of
articles in *Natural History* and *Am*
ican Ethnologist (February 1977) is
propose an explanation of why
Aztecs, among all known human so
ties, sacrificed unparalleled numbers
human victims. If the Fursts have an
ternative explanation, it is not eviden
their remarks. They speculate with e
able certitude that the Mesoameric
could have successfully bred a variet
wild herbivorous mammals for food.
haps such domestication, however d
cult, might have occurred eventually,
Mesoamerica remained the only majo
gion of civilization that lacked dome
cated herbivores for meat or m
Despite its zoological classification
carnivore, the dog can indeed be fed
getal food. But unlike most major dom
ticated herbivores, it still competes
its human owners for essentially the sa
kinds of food, animal or vegetal. As
the Fursts' dissatisfaction with Bor
numerical estimates, the Aztecs and t
neighbors held the world's record, w
ever the actual numbers, for human sa
fice. There were repeated famines
shortages of food despite the tribute
tem and the granaries. In my explana
the human sacrifices were neither
work of madmen nor slavish response
gods with unaccountable tastes,
rather an adaptive solution to ecolog
problems that changed with the introd
tion of Old World livestock in the
teenth century. Aztec cannibalism en
long ago, and modern Mexicans
Mexican-Americans cannot be
responsible.

THE EDITOR REPLIES: The Fursts' im
cation that *Natural History* sho
suppress new theories and protect
readers because they are naïve goes co
pletely against our scientific philoso
and our basic respect for our readers.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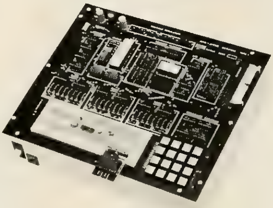

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A Naturalist at Large

by A. Myra K

Paleontological Hoaxes

P. T. Barnum would applaud the success that wily hoaxers have enjoyed at paleontologists' expense

Competition between scientists has meant that the pursuit of knowledge is occasionally sidetracked by hoaxes—deliberate attempts to pass off fake discoveries as genuine. Recent hoaxes, perpetrated by scientific workers under extreme pressure to obtain grants or admission to prestigious institutions, can be considered cries for help. Older incidents have ranged from good-humored pranks to attempts to destroy rivals' careers.

A number of paleontological hoaxes have been so successful that they took years to expose, and some have never been completely unraveled. Vertebrate paleontologists have been favorite dupes, perhaps because bones appeal more to hoaxers' imaginations than do other types of fossils. Two fakes that hoodwinked the paleontological community for long periods were the Calaveras skull, discovered in 1886 in a mining site northwest of Yosemite in central California, and Piltdown man, whose presumed remains were unearthed in 1912 in Sussex in southeast England.

The Calaveras skull caused considerable excitement when it was reported in 1886. It seemed to indicate that man had lived in California during late Tertiary time—more than two million years ago—far earlier than anywhere else on earth. J. D. Whitney, a geologist who had been chief of the California Geological Survey, had accepted the skull as genuine on the testimony of a friend, a physician. In his turn, the good doctor had taken the word of the young miners from whom he had acquired the skull. They claimed to have dug it out of a new mine shaft.

Skeptics, however, pointed out that the matrix, or dirt, inside skull did not resemble the Sie gravels of the mining pit in whic was supposed to have been bur By 1911, both Whitney and his fri had died, and a U.S. Geological S vey report could tell the true stor the Calaveras skull without em rassing anyone involved.

The Calaveras gravels actu contained some genuine foss stumps of palm trees. About the t of the discovery, floodwaters fro nearby stream had washed a num of skeletons out of an Indian bu place. These two events inspire local practical joker to trick the t physician, who was an avid colle of fossils and similar curiosit With the help of some accompli the joker convinced the doctor to cept a contemporary Digger In skull as a Tertiary fossil several lions of years old. But the pranks were not expecting the trusting ph cian to submit the skull as genuin Whitney. Hoping to save face fo concerned, the perpetrators stuc their story. Even though the C veras skull was eventually unmask it became embedded in the litera of prehistoric man as falsely as it been embedded in the gravel sh and it is still sometimes mentione a possible fossil of pre-Pleistoc California man, more than a mil years old.

The story of Piltdown man volved many more individuals, cluding some of the most emi specialists of their time. Although find was proved a hoax in the 19 several mysterious aspects of case, including the perpetrat identity and motives, remain solved. The discovery was first nounced in 1912, when the hi respected English amateur pale tologist Charles Dawson, who ha ready been responsible for some markable finds, sent some fragm

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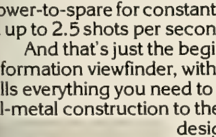

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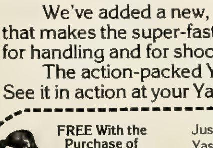

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of a human brain case and jaw to Sir Arthur Smith-Woodward, paleontologist and keeper (curator) of the Department of Geology at the British Museum. Dawson, who later gave several vague and confusing accounts of his original find, claimed that he first noticed the bone fragments in a road workers' gravel pit on Piltdown Common, near Fletching, Sussex. The skull he sent Smith-Woodward was anomalous: the jaw was remarkably primitive; the brain case quite advanced. Yet the two seemed to fit together, partly because the scientific community, on the lookout for tangible evidence of Darwin's theory, wanted to see a match. Smith-Woodward gave Dawson's Piltdown man the scientific name *Eoanthropus dawsoni* and tried to illustrate what he must have looked like.

Dawson led Smith-Woodward to his site, and a number of other paleontologists followed, including Teilhard de Chardin, who was just beginning his scientific career, and an interested amateur named Sir Arthur Conan Doyle, who was then writing about Professor Challenger's discoveries in *The Lost World.* Dawson located another site at Piltdown and he and his visiting colleagues turned up additional fragments—some crude tools, parts of a second skull, and remains of associated fauna, including elephants, rhinoceroses, and beavers. All these finds seemed incontestable proof that man was living in England in pre-Pleistocene time or not later than early Pleistocene (a million years ago), before the Ice Age.

As in the Calaveras case, a few skeptics carped about small discrepancies and complained that the Piltdown skull did not fit into any logical sequence of fossil man's history. Piltdown man was classified as an enigma and usually drawn in on charts of human evolution as a side branch that led nowhere.

Then, in the early 1950s, technical advances in chemical and physical analyses permitted a restudy of the actual material of the Piltdown skull and its associated artifacts. Results immediately showed that the brain case was that of a Neanderthal man whereas the jaw was that of a modern ape. The two parts of the skull had been made to match by staining and breaking down the jaw and filing the teeth. The analysts proved that a second Piltdown jaw could have been manufactured from an ape jaw, but not from the very differently shaped jaw of a genuine early man, such as Heidelberg man. The Piltdown hoaxer foisted his clever deception on the gullible scientific community so carefully and patiently, that to this day no one can positively name him. In his 1955 book, *The Piltdown Forgery,* J. S. Weiner, whose colleagues worked on the chemical reexamination of the fossils, stated that the available evidence points to Dawson, who died in 1916. Dawson's motives are difficult to fathom: he had a well-established reputation, which would have been irreparably tarnished if his trickery had failed. Weiner believes that if Dawson was not the culprit, he was the tool of a blackmailer.

Dr. Johannes Beringer, an eighteenth-century German amateur, was the victim of a third paleontological hoax, an attempted character assassination centered on his *Lithographiae Wirceburgensis,* published in 1726. Beringer successfully combated his persecutors, but his triumph is not part of the apocryphal version of this hoax, which crops up periodically in textbooks and popular scientific literature. The usual version is that Beringer, a German university professor, was so excited by some fossils he had found and took his students on so many field trips to his site that they tired of helping him and began fabricating material for him to discover. This harmless student prank is supposed to have continued unabated until the professor decided to publish figures of all the stones. His students tried to disillusion him by making more and more improbable fossils, such as butterflies sipping nectar at flowers, spiders with their webs, letters of the Hebrew alphabet— all of which Beringer joyously accepted as genuine. His book was off the presses before he found the stone that finally disenchanted him: it had his name on it. Beringer ruined himself financially by buying up the unsold copies of his book and died heartbroken. To recoup the family fortune, his heirs rebound the books and sold them as collectors' items.

But Beringer's story is rather different from this tragic account. In 1963, the University of California Press issued a translation of Beringer's original work, with supplementary notes and some documentary evidence proving that the professor was the subject of something far more serious than a student prank. Dr. Beringer was indeed a professor, in that he was dean of the faculty of medicine at the University of Wü burg in Germany, but he was a court physician and had a lucrat private practice as well. In additi he had established such a reputat as a learned amateur collector curios that he incurred the envy two university colleagues, a librar and a professor of geography a mathematics. They plotted to ur Beringer by casting him in the role a forger of fossils. After fabricat the figured stones, the plotters hi one of the three young men who l been helping Beringer dig and structed him to sell Beringer the *L gensteine* (lying stones) or to pl them where he would find them. May 1725, Beringer saw the first these "fossils": one stone show the sun and its rays and two depict some wormlike objects.

The "discoveries" continued nearly a year. Beringer then judg that he had enough stones to just publication. In the spring of 1726, issued 21 plates, showing some 2 stones. Most of Beringer's text is interesting discussion of theories p viously advanced to account for fos lization. In the academic style of time, Beringer examined these t ories one by one and refuted each. even mentioned the rumors that figured stones were fakes planted enemies, but he discounted the id as unthinkable. Beringer did not tempt to settle the question of h such stones had been formed. He v publishing his illustrations to sh the wonders of "this new stone c lection" and continue the "search truth" about them.

No sooner was the book in pr than the evidence of trickery beca so overwhelming that Beringer, di lusioned at last, felt obliged to defe his honor by judicial proceedin Würzburg court records show tha hearing was held in the cathedral April 1726, and two municipal tri in April and June. The two princip were exposed and declared that th and other shadowy figures in the p had sought revenge because th found Beringer overweeningly ar gant and condescending.

The schemers were duly punishe the librarian, who had been writin history of the duchy of Würzbu was forbidden further access to u versity archives. His manuscript mained unfinished and he died fo years later. The other professor w banished from the duchy, but w later allowed to return after he ask

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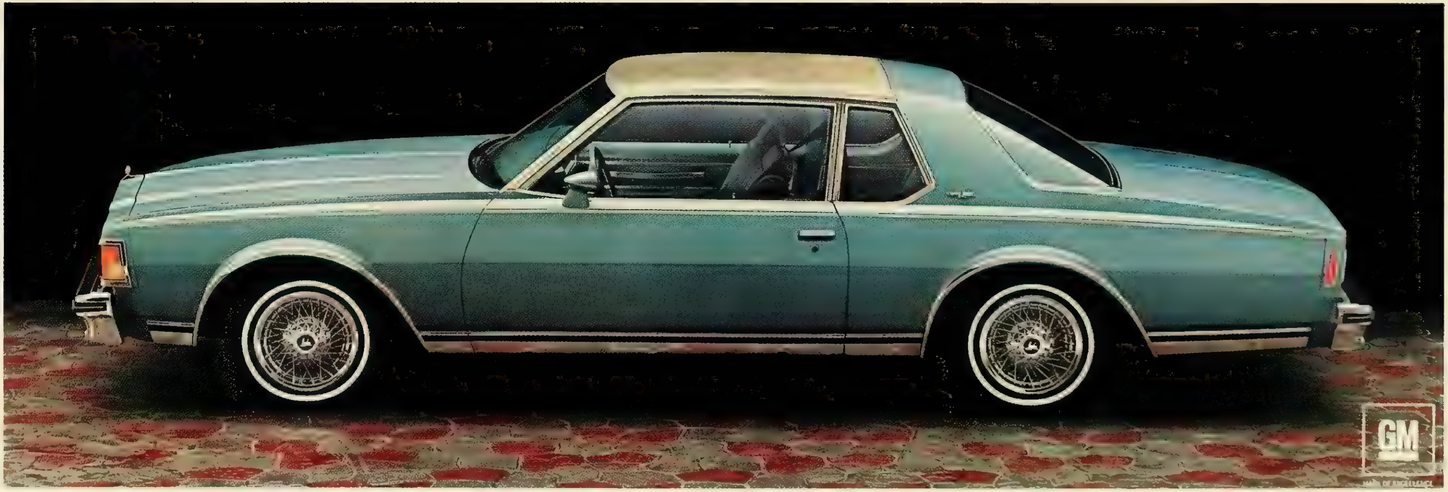

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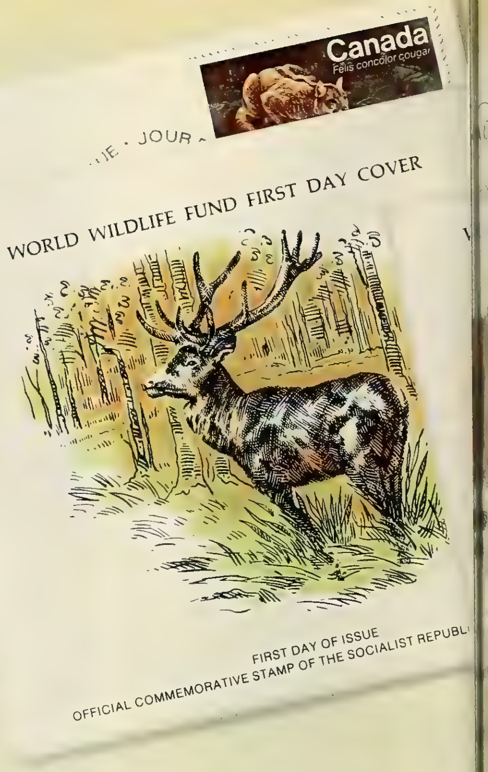
FIRST DAY OF ISSUE
OFFICIAL COMMEMORATIVE STAMP OF CANADA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thoritative commentary discussing the wil
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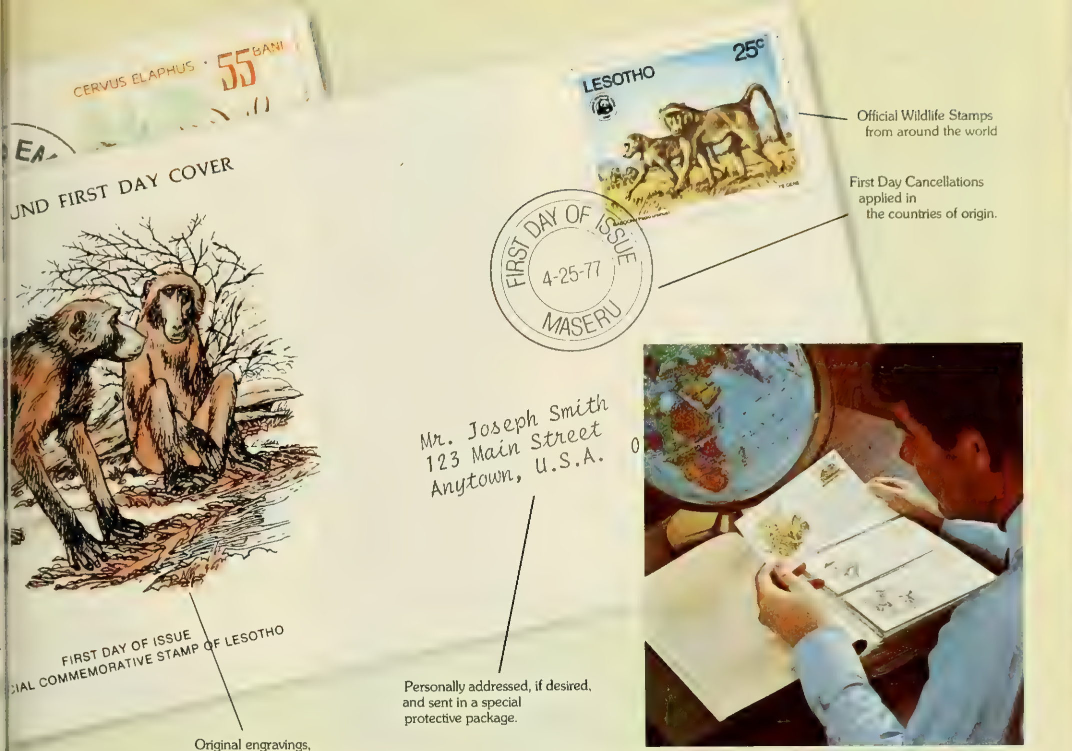

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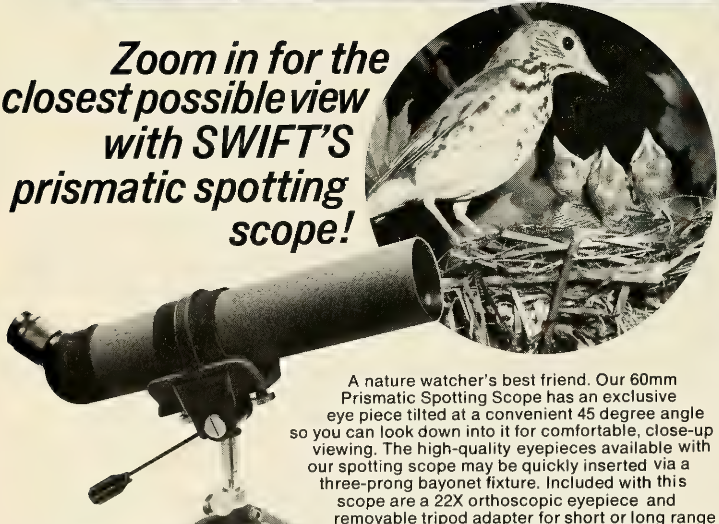

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permission to complete his c
league's unfinished work.

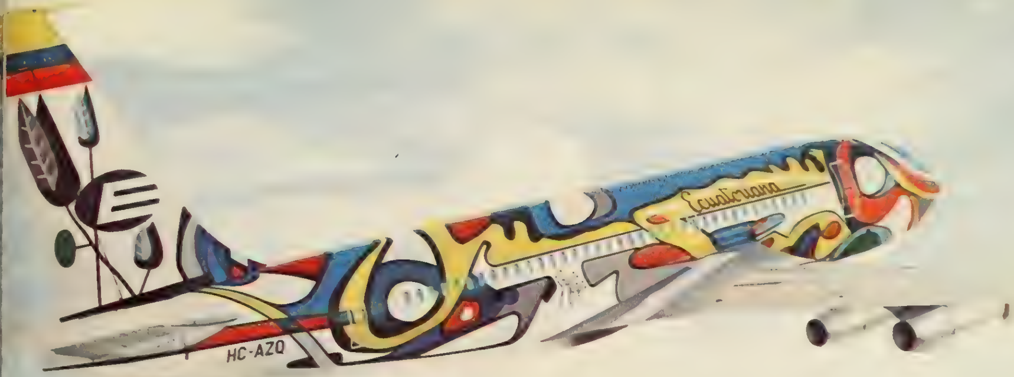
Beringer himself fared much be
than his enemies. He lived on
fourteen years and published two
ditional books that earned him c
siderable recognition. The textb
tale of Beringer is far from accur
he was no small man broken by a s
dent prank, but a victim of prof
sional jealousy who countered the
tack as wisely as he could. The
pressive part of the Beringer cas
which makes it a devastating c
ment on the effects of professio
competition in science—is the
mendous amount of work, expen
and time the perpetrators devoted
their project, presumably out of m
ice alone.

In all three of these hoaxes, so
one deliberately tampered with
fossil record and placed phony m
rial where it would be conside
genuine. In the Calaveras hoax,
pranksters never anticipated seri
consequences, and their skull beca
celebrated only because Whitney
well-known scientist, had accepte
as genuine. But Whitney was a geo
gist, not a paleontologist, and he
viously had not been sufficiently cr
cal.

Piltdown man, a more comp
case, was the work of someone de
mined to prove a cherished thesis
the existence of a "missing link
pre-Pleistocene man—even if he h
to manufacture the evidence hims
No practical joker would have ris
his scientific reputation as this m
did. Nor would a prankster have bo
ered to gauge so accurately the cre
lity of the scientific community.

While no more credulous than
more modern colleagues at Piltdo
and Calaveras, Beringer laid hims
open to treachery because, like m
scientists of his period, he substitu
reasoning for experience. If he h
done his own digging, he would ha
noticed that the lying stones w
never found in undisturbed strata.
his book was by no means useless:
text was a model of shrewd think
about fossil formation, and the st
of his misfortunes should have serv
as a warning to future paleonto
gists. The workers at Calaveras a
Piltdown simply had not paid att
tion.

*Dr. Keen is professor emeritus of p
leontology and curator emeritus
malacology at Stanford Universit*



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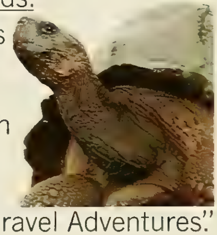

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Farming the Edge of the Andes

by Stephen B. Brush

photographs by Victor Englebert

Despite assurances of bountiful harvests through the use of Green Revolution technology, some Peruvians wisely follow centuries-old planting strategies

High in the Peruvian Andes before planting time, peasants sort over their collections of seed potatoes, selecting out of a possible fifty varieties those types that will be suitable for particular fields. In spite of low productivity, the many varieties of one plant and the way they are planted assure the peasant that he will not starve if drought, flood, or disease destroys part of his crop. These traditional patterns allow him to farm with minimum dependency on far-flung trade networks that are often liable to economic and political vagaries.

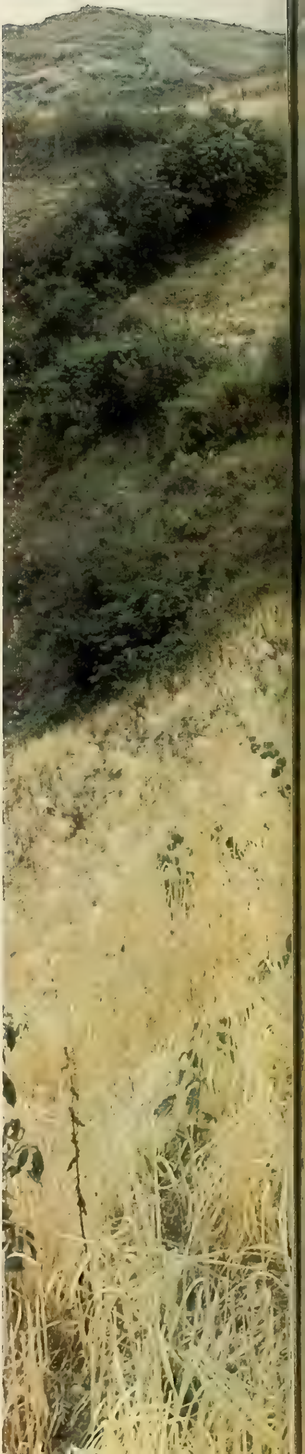
In contrast to the diversity of peasant fields, the advanced agriculture of industrialized nations strives toward the high production of one crop through extensive genetic experimentation and soil fertilization. Peasants in many parts of the world are being induced to abandon their traditional agriculture and to adopt the results of the newer technology. Within the last decade, pressure for this change has increased with the breeding of high-yielding varieties of maize, wheat, and rice, and with the profitability of transferring technology from Western to third world nations. Rapid population growth, the costs of importing food, and the rural exodus to cities have pressed the urgency of this change. The admirable goal of this effort—known as the Green Revolution—is the provisioning of an increasingly hungry world with food. But as this revolution proceeds, lessons that could be learned from traditional peasant agricultural systems are mostly ignored.

In the Peruvian Andes, where traditional agriculture predominates, peasants deal with one of the steepest environmental gradients in the world. Single mountain slopes, often spanning several thousands of feet in altitude, embody numerous ecological zones where there are differences in temperature, rainfall, exposure, slope, drainage, and soil composition. Altitude and exposure determine the different plant communities that grow in these zones.

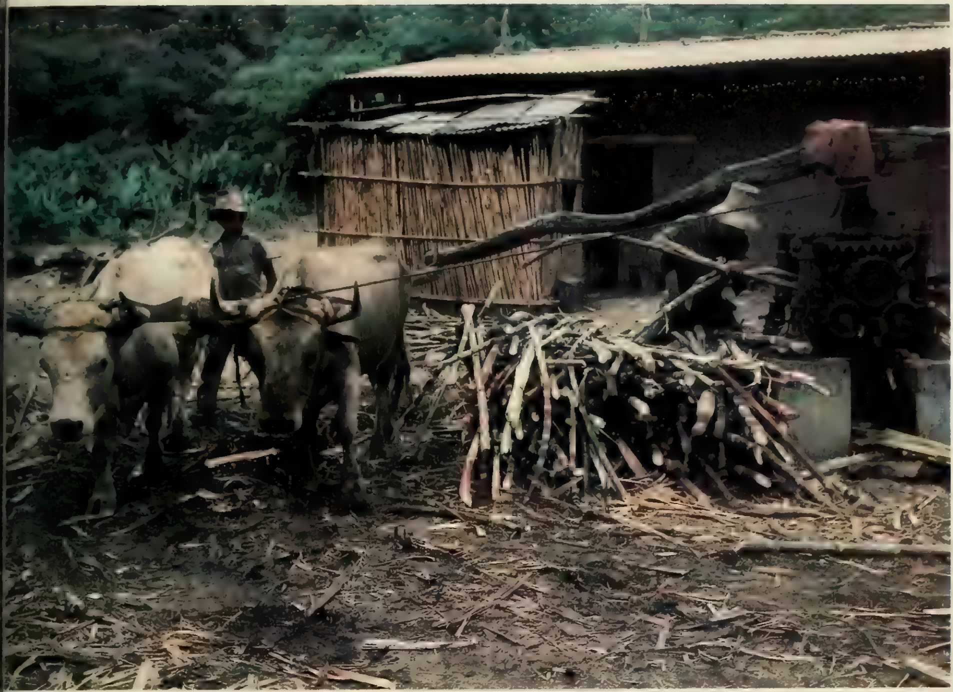
The agriculture of both peasant societies and great civilizations such as the Inca Empire has been based on a finely tuned understanding of the ecosystems that span the Andes from the dry Pacific coast to the dense jungles of the eastern foothills. This sensitivity persists into the present.

Uchucmarca is one village whose survival has depended on a close adherence to steep valley ecosystems. Located in northern Peru near the Marañón River, a principal tributary of the Amazon River, the village is situated at an altitude of 9,950 feet, halfway up a forty-mile-long valley that covers more than 10,000 feet in altitude. The valley's climates are as diverse as those along a line from Texas to Alaska.

Slightly more than one thousand people live in Uchucmarca and another thousand live in smaller hamlets and homesteads scattered throughout the valley. Like many other isolated



Barley grows on about one-fifth of the land belonging to Uchucmarca. More cold-resistant than wheat, most barley is raised at an altitude of about 10,000 feet.



Sugar cane, an abundant crop in the lower valley, is crushed in oxen-powered mills. The resultant cane juice is boiled down and molded into five-pound blocks.

ages on the eastern slopes of the
des, Uchucmarca is connected to
outside world by steep mountain
ls passable only by foot and on
seback. The nearest road is six
rs away and a twelve-hour jour-
is required to reach the nearest
rket center with such amenities as
ctricity.

Uchucmarca's self-sufficiency
nes from the wide variety of crops
duced in the valley's six ecolog-
zones. Although the zones blend
each other, their different alti-
es produce a gradient of environ-
nts. The lowest zone, between
00 and 4,900 feet, is a narrow al-
ial basin between steep, dry hills
dded with columnar cacti and
thorny trees. Lying well within the rain shadow of the eastern cordillera, this area receives no appreciable rain, and the zone's principal crops—sugar cane, coca, manioc, chili peppers, and fruits—must be irrigated.

Above this zone, the *kichwa fuerte* zone runs up to 6,200 feet. In this area the valley widens and increased rainfall allows a dense scrub forest. Although precipitation is still too sparse and irregular to support extensive cultivation, some families venture to grow wheat and maize here. For most people, the important product of the *kichwa fuerte* is firewood, a resource rapidly being depleted.

The major grain-producing zone, the *kichwa,* climbs from 6,200 to 8,200 feet in the wide, middle valley below grass-covered hills. Uchucmarca's farmers believe this area contains the valley's optimal agricultural land, with warm days, frost-free nights, and a regular annual rainfall of about twenty inches. During July and August, almost the entire village population decamps for this area to spend a month or two enjoying the mild climate and harvest festivals.

Above 8,200 feet the valley narrows again as the *templado* zone begins. As its name implies, this is a temperate area situated between the warm, drier zones in the lower valley and the cool, moist ones above. Steep slopes covered with low bushes and trees preclude extensive cultivation. But on more level ground, a wide variety of crops such as maize, wheat, barley, lentils, and field peas are grown.

Uchucmarca is located at the lower end of the next zone, the *jalka*. Lying between 9,900 and 12,000 feet, this zone is the center of the cultivation of potatoes and other tuberous crops. Potatoes are the bread of the Andean

st households keep some sheep
two reasons: the wool is used
virtually all clothing and
manure is the only fertilizer
t potato fields receive.

Bread baking is a cooperative activity in which one family owns a beehive mud stove, another contributes firewood, and a third provides the labor. All bread is made from locally grown wheat.

ne Uchucmarcan women are
ving specialists. Weaving a
cho-sized garment may take
two weeks, but spinning the
l may take several months.

ple. No meal is satisfactory with-
them, and hunger is defined by
r absence. The origins of Andean
lization may be traced in part to
iculture in the *jalka*. In this valley,
n modern and pre-Columbian pop-
ions expended more labor on
e land for these crops than for any
er. Temperatures are cool here,
frosts are common during the
r nights of the short dry season
ween May and September.

bove this zone, the *jalka fuerte*
e ascends to almost 15,000 feet.
e, above the limits of crop cultiva-
, rolling pastures of bunchgrass,
ge, and Andean tundra are swept
cold winds and are often covered
clouds that tumble down from the
tern Andean cordillera—a line of
ggy rock outcrops and cliffs where
dors nest. Llama and alpaca have
g since disappeared from these
tures, although their prehistoric
ndance is evident in the ruins.
w, cattle, sheep, horses, mules,
pigs graze here, representing the
st important source of cash to the
agers.

The Uchucmarcan economy in-
des subsistence strategies de-
ned to provide access to these eco-
ical zones and their products for
h individual household. Although
person has absolute ownership of
parcel of land—a right held ex-
sively by the village—individual
useholds are granted virtually per-
nent rights through inheritance or
the village council.

Like most peasants in Latin
ierica, the Uchucmarquinos present an image of egalitarian poverty. Most families, however, are fairly well off in that they have enough food for the table. The daily fare is simple: wheat cakes of stone-ground whole wheat flour, parched and roasted maize, beans or peas, roasted barley flour, mutton soup, a few pieces of dried beef or mutton, and quantities of steamed potatoes.

An average family of four persons cultivates about five acres of land that are spread among small plots in various parts of the valley. Using only simple tools—a short-handled hoe, a pick, and a shovel—and with only oxen to supply power, agriculture is arduous and time consuming. Hiking to and from cultivated plots may occupy several hours per day. My research reveals that the average farmer spends almost 60 percent of his work time tending his fields and herds.

Most households attempt to obtain rights to as many parcels in as many zones as possible. Shortages of land and labor, however, prevent most households from achieving self-sufficiency. These shortages are compensated for by a set of alternative stratagems, such as reciprocal labor exchange, hiring laborers who are paid in crops as well as in cash, barter between households specializing in one crop, and a system of sharecropping that exchanges land for labor. Every household in the village employs each of these stratagems to some degree.

To insure a full larder, households try to grow six or seven different crops in different parts of the valley. Another guarantee is to plant the same crop in several fields. A single household may thus have three or four potato fields in the *jalka,* as well as fields planted in wheat, barley, maize, and field peas in two or three of the lower zones. The peasants may also diversify crops in one field: maize, squash, and beans, for example, are always planted together because these different crops utilize different soil nutrients. This tactic may balance the failure of one crop with success in another if a family does not cultivate numerous plots.

Another way to reduce the risk of food shortage is to plant numerous varieties of one crop, especially potatoes, in a single field. There are more than 2,000 named potato varieties in Peru; in Uchucmarca alone, the peasants can identify some 50 varieties. The potato is indigenous to the Andes, and the area harbors a tremendous gene pool, both wild and domesticated. In the Andes, continuous cross-pollination between domesticated and wild potato varieties frequently creates new strains.

This large number of potato types provides some measure of security for the average Andean peasant. Agricultural success in Uchucmarca is fraught with danger: from earthquakes, landslides, hail storms, and sudden frosts, as well as damage by insects and disease. Saints, such as San Isidro, who watch over the fields and who are favored with candles, prayers, and fiestas do not guarantee success. Although all families depend on different crops as well as on their kinsmen and neighbors, their final safeguard against hunger is their ability to grow enough potatoes.

In most traditional communities, a first line of defense against crop destruction is maintenance of as wide a genetic base as possible and selection of different types more resistant to frost, blights, and insects. But no single variety of potato is able to withstand all of these, and none has total resistance to any single pest. By growing many varieties, however, the peasant reduces the risk of hunger if one field or variety is attacked by a particular pest.

In Uchucmarca, a common practice is to plant fast-growing varieties during the drier part of the year; this avoids late blight, which increases during the months of heavy rain. Another practice is the cultivation of certain frost-resistant varieties in flat, bottom areas of the high valley where frost, but not late blight, is common. Other varieties are cultivated on hillsides where late blight, but not frost, is common.

A third stratagem used by Uchucmarcan peasants to assure a potato harvest is to cultivate fields for only one to three years before returning them to a long fallow of eight or more years. Farmers usually sow potatoes in the first year and other Andean tubers—oca (*Oxalis tuberosa*), mashua (*Tropaeolum tuberosum*), and ullucu (*Ullucus tuberosum*)—for one or two subsequent years. The long

ize is consumed in several ways:
nels are mashed into hominy or
sted or partially sprouted, dried,
then fermented into chicha,
traditional Andean beverage.

fallow period lowers subsistence risk in two ways: by reducing the amount of erosion and soil loss and by killing disease vectors such as nematodes and fungi, which remain in the soil and depend on continued potato plantings to survive.

A final means of reducing crop destruction is the bordering of fields with hedgerows of living plants such as sauco bush and agave. Ostensibly maintained to keep out destructive livestock, the roots of the plants retard soil loss due to wind and water erosion and create quasi terraces. Soil loss is also reduced by plowing and cultivation, which tends to build up soil behind the hedgerow, slightly leveling the field on steep slopes. Hedgerows also provide refuges for wild varieties of domesticated plants as well as for insects, which pollinate, and birds, which prey upon pests. Despite criticism leveled at hedgerows for the space they require, they are one of man's most important agricultural inventions.

In spite of the success of isolated villages in meeting their food requirements, Peru faces annual food deficits and must import food. Agricultural production has not grown as rapidly as the population. To meet this dilemma, the Peruvian government and international development agencies initiated a program in 1974 to develop high-yielding potato varieties and to promote advanced agricultural technology based on the extensive use of chemicals. This effort, centered at the International Potato Research Center outside of Lima, is modeled on research programs for maize and wheat in Mexico and for rice in the Philippines. Although a miracle-variety potato may never be produced, several new strains have been developed that are capable of substantially higher yields than the traditional ones. These new varieties may increase yields by two or three times those of traditional varieties, lifting production from roughly three to eight or nine tons per acre. Along with agrochemical technology, these varieties have been introduced to several areas of Peru.

Uchucmarca and other villages along the eastern slopes of the Andes, however, have not adopted these new varieties or the new technology. Peasants say that the new strains are tasteless and of a watery consistency. Traditional varieties, especially the favorite floury-textured ones, tend to be higher in protein and have better protein quality than the improved strains. Crude protein of the native types averages roughly 2.48 percent versus 2.07 percent for the new types. Protein equivalency ratios—a measure of protein quality—indicate that some of the native varieties are more than 50 percent higher in quality than the most commonly planted "improved" variety. Also the new strains require heavy fertilization, while the traditional varieties do not. Good-tasting potatoes, by Andean standards, are incompatible with heavily fertilized fields.

Another deterrent is that the seeds of the new varieties and the technology they require are far too expensive for peasants: fertilizer, fungicides, and insecticides alone cost about sixty dollars per acre. There are no public or private loans available in the valley, and the present scale of potato production by an individual household does not now justify the long and expensive journey needed to search for credit. Uchucmarcan peasants are accustomed to producing potatoes with little or no cash expenditure. The average annual cash investment per plot is less than two dollars, the cost of hiring a team of oxen for two or three days. Outside labor, if needed, is traditionally paid for in the crop itself.

The general adoption of the new varieties would eliminate the rich gene pool of indigenous varieties and force the farmer onto an ecological high wire where the narrowly based genetic crop may fall prey to a recently evolved disease. Examples of such disasters are plentiful: the 1970 corn blight in the United States, coffee blights in Brazil, and the Irish potato famine of 1845. Further reduction in the gene pool of indigenous varieties may severely limit the ability to respond to such genetic dangers.

The developers of new high-yielding varieties are aware of this danger and have countered it by creating germ-plasm banks such as the U.S. Department of Agriculture station at Fort Collins, Colorado, where seed varieties of one crop are frozen or tubers are kept in cold storage. Such methods are satisfactory, provi
the seeds and tubers remain via
under such conditions and the
chinery for keeping them does
fail. Recognizing that neither of th
provisions is certain, Hugh Iltis
botanist at the University of Wisc
sin, has proposed maintaining
lected "genetic landscapes," that
setting aside regions where spec
crops would be off limits to agric
tural technology. Such a propo
would avoid accidents, such as pov
failures, and allow the natural proc
of cross-pollination between wild a
domesticated species. Iltis reco
mends the establishment of an int
national potato diversity preserve
the Lake Titicaca basin of Peru a
Bolivia.

Like the native potato fields,
economies of traditional villages
relatively stable, but low-yieldi
systems. The adoption of new, hi
yielding crop varieties and agroc
mical technology depends on restr
turing traditional cultural and e
nomic patterns. But Keith Griffin,
economist at Oxford Universi
notes that the credit and rural assi
ance that supports the Green Revo
tion is often biased away from
peasant in favor of large commerc
producers. Francine Frankel,
economist at the University of Pe
sylvania, has observed the effects
this bias in India, where the liv
standards of the poorest peasa
have deteriorated in some areas a
where the Green Revolution has
dermined traditional peasant relati
ships. If these services and subsid
fail, the peasant may have no alter
tive but to join the exodus to citie

The passing of traditional cultu
under the guise of modernization
sults in a world made the poorer. T
passing may be inevitable. What
not inevitable, however, is the loss
these cultures' insights and
sources, so essential for the future
our hungry planet.

After harvesting and threshing
barley, peasants dry the grain
the lofts of houses. Hydraulica
operated mills in Uchucma
grind the grain into flo

How Mussels Get Attached

by Arnold Tamarin

This mollusk produces a remarkable adhesive whose strength and durability are of interest to dentists and surgeons

The animal kingdom has numerous examples of species whose life-styles entail attachment to a surface. The methods of attachment used by different animals demonstrate a wide range of mechanisms developed in response to various environments and feeding habits. In the world of fish, for example, the remora is a hitchhiker and saves energy by clasping the underside of sharks by means of a suction device on the top of its head. By detaching and reattaching from the shark at will, this fish can swim independently when necessary. At the other end of the spectrum are species, such as barnacles and oysters, that anchor themselves permanently to available hard surfaces and are not free to move about on their own. Such animals have developed specialized glands that secrete cementing substances, which become mineralized to create rigid, unbreakable connections between their shells and the sites of attachment.

The sea mussel (*Mytilus*) and some other bivalve mollusks have developed a unique attachment mechanism termed the "byssus," which consists of materials secreted by glands located in the foot. Marine mussels live mainly in beds along the coastal shoreline, where they are daily exposed to pounding surf and changing tides. The byssus accommodates the mussel's requirement of semipermanent attachment in its variable environment. Although mussels are considered to be sessile, or permanently attached, animals, they do retain a limited freedom of movement that enables them to survive the shifting currents and silt in their intertidal habitat.

Aristotle appears to have provided the first description of mussels being "rooted" in sandy and muddy places. A few medieval treatises on bivalves provided accounts of the byssus and interpreted the structure as a plant growing from the surface to which the animal attaches. The first accurate interpretation of the byssus as a holding device fabricated by the mussel itself was published by the German naturalist Conrad Gesner in 1558. The first scientifically detailed study of a byssus-forming bivalve was printed in 1882. Around the turn of the present century, greater interest in the biology of mussels was generated by the fishing industry's recognition of their commercial value as human food and as bait. In England, and especially in Scotland, marine biologists were becoming sensitive to the effects of water pollution and of man-made topological changes, which adversely affected the ecological status of natural mussel beds in estuaries.

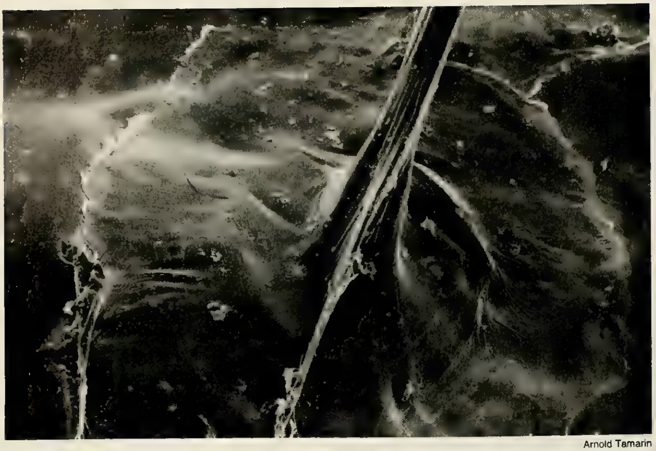
Some of the current interest in the biology of mussels comes from a new quarter. Since adhesives play a fundamental role in a vast number of modern manufacturing processes, the bonding substances formed by living organisms are exciting the curiosity of scientists as a possible source more knowledge concerning t physical-chemical nature of adhesi in general. Further, the possibility discovering new "glues," whi might solve some present problems be adapted to new uses, is a tantal ing prospect. From the standpoint glue technology, the mussel is a p ticularly good subject from which learn some secrets about adhesion.

The byssus is formed and holds f under adverse conditions—und water and in the presence of erra stresses caused by the turbulence currents and waves. In addition, t bonding material withstands repeat wetting, drying, and temperatu changes caused by the ebb and fl of tides. *Mytilus* is also a good subj for study from an experimental stan point because living specimens a easy to get, they do well in laborato aquariums, and they are easily i duced to form new attachments.

In the species *M. californian* the byssus has a tan color and consi of five parts, one of which (the ro is discernible only upon dissectio At low tide the casual wader in mu sel beds can recognize a cylindric rod extending from near the midd of the straight edge of the tigh

Sea mussels live in intertid areas. The species Mytil californianus *is found along t Pacific coast from San Die north to Vancouver Islan*

David Mue



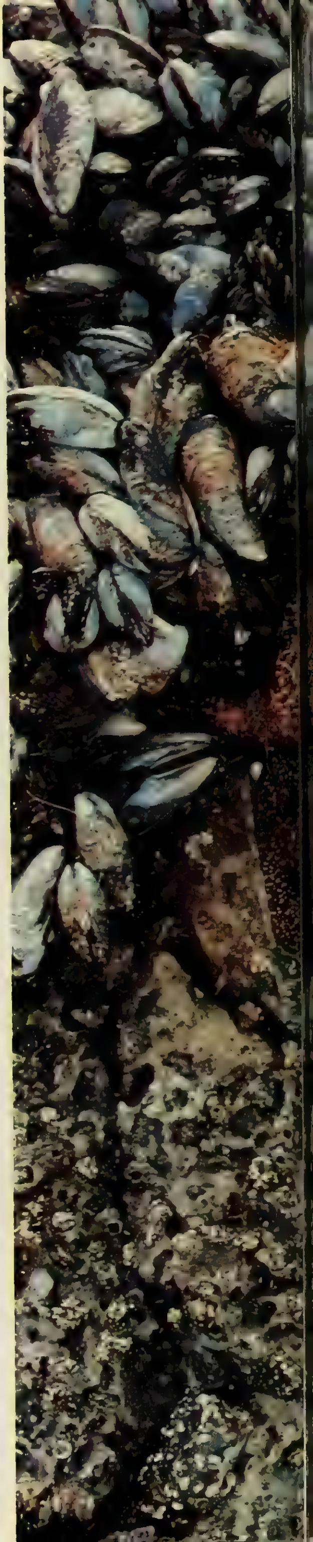
Arnold Tamarin

The flattened disk, or attachment plaque, with which the mussel holds fast to various surfaces, can be seen at the end of a thread in this micrograph taken with a scanning electron microscope.

closed shells. Attached to this rod, the byssus stem, are a variable number of threads, usually about a dozen, but occasionally as many as one hundred. The end of each thread terminates as a flattened disk, called the "attachment plaque," that adheres strongly to the surface of rocks, the shells of neighboring mussels, or whatever surface is convenient. When forcefully pulled, a mussel can be lifted from the bed, but only at the expense of broken threads since the disks remain firmly attached to the underlying structure.

Close examination shows that the threads are connected to the stem by means of overlapping flattened rings, arranged like a stack of paper cups, that encircle the stem. The part of the thread adjacent to the ring is slightly flattened and corrugated. When the mussel shell is pried open, the stem is seen to protrude from a pit in the fleshy eminence at the base of the animal's foot. By patiently working the stem back and forth with a firm twisting motion, the root can be extracted. The root consists of innumerable thin, parallel, opalescent gelatinous sheets, which converge to form the base of the stem.

How does the mussel make this remarkably complex anchoring device? What is it made of? How does it work? Some of these questions can be answered by observing a mussel as it attaches to the side of a laboratory aquarium. The shell opens slightly and the foot is extended by an internal hydraulic system so that the tip is free to grope for an appropriate attachment site. When ready, one side of the tip is firmly applied against the glass with a squirming motion, like that of a child pressing its tongue against a windowpane. A turbid material then flows out of a depression near the end of the foot, and after a few moments, the foot is withdrawn leaving behind a disk and a thread that emerges full length from a longitudinal groove on the surface of the foot. The groove extends the length of the foot, from the depression near the tip to the pit from which the stem emerges. Thus, the depression, the groove, and the area around the stem within the pit form one continuous space that acts as a mold for the "casting" of the disk, the thread, and



Starfish are predatory creatures. Among their prey are mussels whose shells the starfish can open by means of the suckers on their several arms.

Bob Trelease, Sea Library

rings as a continuous structure.
licroscopic studies provide an in-
it into the manner in which the
erent parts of the byssus are
ned and secreted. At least five dif-
nt substances are synthesized in
process by five distinct types of
ld cells. The individual cell is
ped somewhat like a rounded hot-
er bottle, with a long, narrow,
ding extension at one end. The
body is about one-thousandth of
inch in diameter while its exten-
is one-fifth as wide but may reach
-fourth of an inch in length. Al-
ugh their shapes and sizes are
re or less comparable, the five cell
es differ in their distribution and
he appearance of the characteristic
nules they secrete. One cell vari-
makes granules, shaped like
newhat rounded footballs, that are
d with evenly spaced parallel fila-
nts. This material is a form of col-
en, the protein responsible for the
gh, stringy character of tendons.
er the granules are formed in the
le part of the cell, they move along
narrow extension that terminates
free surface where they are ex-
led. Other gland cells have dif-
ently shaped granules containing
er materials but secrete them in the
ne manner. The nature of one of
remaining materials is still not
own, but the chemical composi-
ns of the others have been tenta-
ely characterized as a type of
cus, a phenolic protein, and an en-
ne that converts the phenolic pro-
into a tanning agent. Collagen is
reted into all parts of the byssal
paratus. The mucus, the phenol
npound, the enzyme, and the un-
own material are selectively se-
ted. Thus, each part of the byssus
ntains some collagen but has its
n individual total composition.
Too little is known about stem formation to offer much information at this time. But it seems that secreted collagen mixes with the chemically unidentified ingredient to form the gelatinous root sheets that form the stem. Hardening of the stem may be the result of contact with seawater.

It is thought that formation of the tough byssus threads may result from a chemical sequence in which the enzyme converts the phenolic protein into a tanning agent, which, in turn, cross-links the collagen molecules—a process akin to the tanning of leather. At this point it is interesting to note that the tough character of the byssus has been recognized by Mediterranean coast dwellers for at least a thousand years. Weaving the threads into gloves, scarfs, and purses was long a common home industry, which, unfortunately, is now becoming a forgotten art.

The formation of the adhesive disk is less straightforward and less well understood than the formation of other structures. But on the basis of electron microscopy, a plausible theory has been formulated. Through the mixing action of specialized paddlelike fine hairs, or cilia, within the depression in the foot, the mucus is suspended as tiny droplets in the phenol compound. When this emulsion contacts an appropriate surface, the droplets act as points of instant stickiness that are temporarily enhanced by the presence of water—a characteristic of mucus in general. The phenol compound, which forms most of the common boundary between the disk and the attachment surface, requires more time to establish chemical bonds between its molecules and those of the attachment site. The temporary stickiness of the mucus allows this to happen by immobilizing the disk long enough for the phenolic chemical cross-linking to take place. Since cross-linked phenol compounds are insoluble in water, and since their synthetic industrial counterparts make good glues, this theory of disk formation is compatible with current knowledge about the physical and chemical requirements for strong adhesion.

From the foregoing, it appears that the byssus works in the following manner: the threads serve as guy wires, cemented by the disk at one end and attached to the stem at the other. The flat corrugated segment next to the stem acts as a shock absorber, which stretches out in response to the buffeting of waves. The flat rings are structurally an extension of the thread, connecting it to the stem. The stem and root function as a continually replenished connector between the animal and the threads and also as a fixed point from which retractor muscles gain leverage.

In its watery environment the mussel can use its byssal apparatus for locomotion much as an expert mountain climber uses ropes and pitons. The powerful retractor muscles enable the animal to snap a few threads on one side by pulling against many on the other side. This allows the mussel to crawl forward using its foot in a snaillike fashion. When the remaining threads are drawn taut, the foot is extended to deposit a new set of disks and threads. By repeating this process, a mussel can even climb a vertical glass surface. All in all, the byssus is an elegant solution to a complex problem.

There is much more to learn about the byssus, especially with respect to the chemical composition of the various substances from which it is formed, and a number of research teams are currently working on this problem. Since the byssus is very resistant to dissolution, it does not easily lend itself to direct analysis. Therefore, attempts are being made to isolate the glandular tissue within the mussel foot and to separate the different types of cell granules before they are secreted. This is a tricky procedure because the proximity of the various cells causes their long extensions to intertwine. Unfortunately, the available techniques for collecting granules from cells also break some of the granules, and when that happens, a mixture is created in which the intact granules tend to clump, thus resisting separation into pure samples.

Despite such difficulties, progress is being made. As the chemical puzzle unfolds, there is anticipation that certain aspects of the byssus attachment process in mussels may be applicable to the design of better man-made adhesives for use in surgery and dentistry, where moisture and movement are now obstacles to ideal adhesiveness. ☐

ussels and barnacles often
are the same habitat. The
rnacles attach themselves to
mussels and the two
ganisms live in a commensal
ationship in which neither
e interferes with, or
ntributes to, the other.

, Sea Library

Shelters on the Plains

by Roger Welsch

The hinges are of leather
And the windows have no glass;
The board roof lets the howling
  blizzards in;
I can hear the hungry coyote
As he slinks up through the grass
'Round that little old sod
  shanty on my claim.

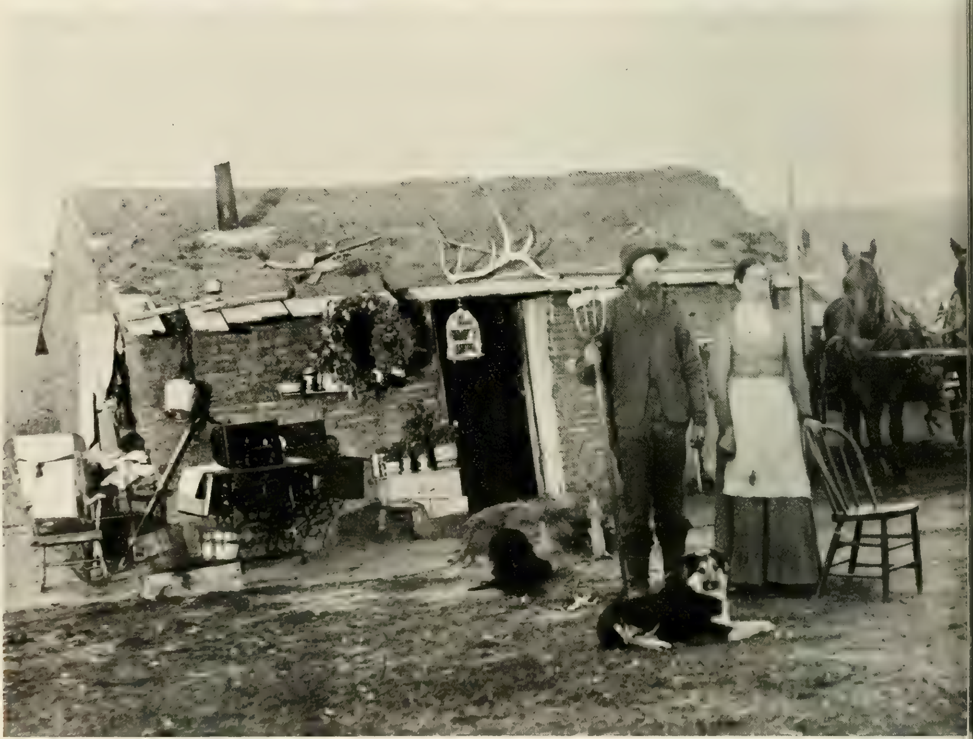
Chorus of a Pioneer Plains Folksong

Even today the Great Plains crush travelers between the endless sky and a landscape that undulates like swells of the sea. But now, there are at least occasional trees and farmsteads, roads and telephone lines that delineate and articulate spaces within a land otherwise devoid of landmarks. Most of today's plains dwellers know the landscape and regard the climate and space as slight discomforts at worst, in contrast to the migrant homesteaders of the nineteenth century who had never imagined such a place in their worst dreams.

Then there were even fewer trees than now and the grasslands were not so neatly and reassuringly divided into sizes the mind could digest. The term "prairie schooner" was only barely a metaphor. Ole E. Rölvaag, the Norwegian-born author, portrayed the life of the immigrants and described the vastness of the plains in his 1927 novel, *Giants in the Earth,*

> Bright clear sky over a plain so wide that the rim of the heavens cut down on it around the entire horizon. . . . Bright clear sky, today, tomorrow, and for all time to come. . . .
>
> And sun! And still more sun! It set heavens afire every morning; it grew w the day to quivering golden light—tl softened into all the shades of red a purple as evening fell. . . . Pure cc everywhere. A gust of wind, sweep across the plain, threw into life waves yellow and blue and green. Now and tl a dead black wave would race over scene . . . a cloud! . . .
>
> It was late afternoon. A small cara was pushing its way through the grass. The track it left behind was like wake of a boat—except that instead widening out astern it closed in again

The agony of frontier life on t plains is immortalized on tom stones, in the lyrics of folksongs, a in journals and daybooks. But chives often do not contain inform tion on how people responded to sp cific conditions. I therefore turned



All photographs from the Nebraska State Historical Society

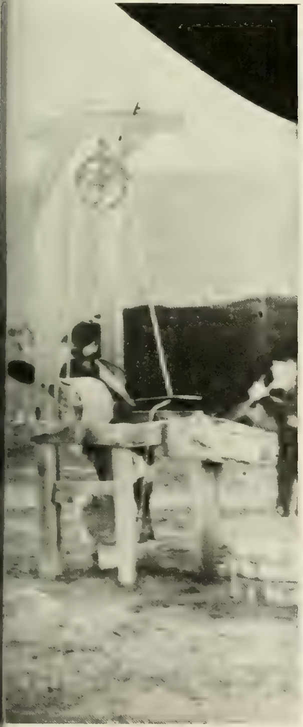
urce usually ignored by those who
ly folk architecture—the writers
he plains. I reasoned that these
ts and novelists had based their
es of success on a sensitive per-
tion and faithful rendering of the
neer experience. Such subjective
creative data necessitated careful
luation; but then so must any
d-gathered information.

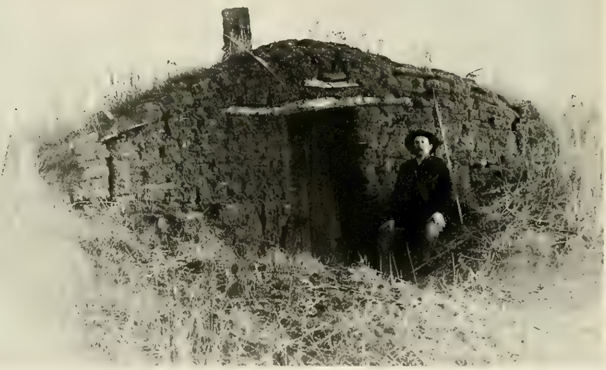
reread the works of such writers
Rölvaag, Willa Cather, Mari San-
, and Bess Streeter Aldrich, as
l as the essays of architectural his-
an Amos Rapoport, architectural
losopher Gaston Bachelard, and
nographer John Demos, looking
clues to an understanding of the
ure and degree of the impact of
ins geography on the mind of the
grant. The message was clear: the plains were a mysterious land of frightening, unbounded space.

The intensity of plains geography was made all the sharper by the lens through which it was first seen by the pioneers: the eyes of hopeful immigrants—from Norway, Germany, Czechoslovakia—or of settlers from other parts of the United States, such as Wisconsin, Illinois, and Connecticut, where landscapes were more manageable. These people were accustomed to a perspective foreshortened by trees, rocks, lakes, and streams—rural scenes relieved by stone or timber fences a few hundred feet apart, by farmsteads numbering two or three to the eyeful.

The German farmers were accustomed to walking in the morning to fields they could shout across and then returning in the evening to a house among other houses, where there was company and communion. On the plains they farmed areas ten times bigger than they had in the Old Country. There were no fences, trees, or rocks, few neighbors within an hour's ride, and the nearest town was days away.

The distances were only one of the brutalities the Great Plains region dished up for its challengers. The temperature range exceeded, by twenty degrees at the top of the thermometer and forty at the bottom, any they had ever experienced in their homelands. The daily range could equal the annual range in Holland. In Czechoslovakia, there had been no prairie fires racing through the tinder-dry grass faster than a man on horseback.





Sod houses could be extremely simple in their construction. The simplest were built low to the ground and had no windows. From a distance, these dwellings often took on the appearance of animal burrows.

Portraits taken in front of sod houses were common during the 1880s. To document their success at surviving on the plains, families wanted all their material goods included in the photographs.

There had been no rattlesnakes and swarms of grasshoppers in Belgium; no cacti, buffalo, or vengeful Indians in Sweden. On the plains, the wind tore the covers from wagons and thunder shook the dishes from shelves. Hailstones, of a size that could kill horses, fell with terrifying abruptness. Trickles that would not have been worthy of a name in Germany were called rivers here, and like the Platte, they flowed—as some said—upside down, "with the sand on the top and the water underneath."

Thus the geography of America's northern plains region—Kansas, Nebraska, the Dakotas—offered climatic, social, and emotional violence that demanded the sturdiest of shelters. Yet, paradoxically, the plains withheld all the materials the settlers had traditionally used for building. There was little stone, even for chimneys; little wood, even for cooking. The most logical first thought would be hasty retreat.

Rölvaag's powerful writing grew from his own experience in the wilderness: one of his characters faces a future on the plains and cries, "How will human beings be able to endure this place? Why, there isn't even a thing that one can hide behind!" Retreat is a universal motif in plains literature and folklore. A character in Willa Cather's novel *O Pioneers!* agonizes, "The country was never meant to live in; the thing to do was to get back to Iowa, to Illinois, to any place that had been proved habitable."

Consider just one aspect of what the pioneers experienced as they moved westward—the change in forestation. During the nineteenth century, Indiana was almost totally forested in hardwoods—mostly oak and walnut. Forty percent of Illinois was forested; Iowa only 18 percent, hinting, perhaps, at what lay ahead. Nebraska, Kansas, and the Dakotas were 3 percent forested, mainly in a line along the Missouri River at the eastern edge of the Great Plains.

And yet the promise of owning land, a farm many times the size of farms in the Old Country (where the possibility of ever possessing even a small one was unlikely) steeled the settlers' resolve to stay and blurred the impact of the catalog of trials they encountered. Besides, most of them had spent everything they had, in both money and pride, to get here, and they could scarcely turn back.

These people had to build houses. They quickly used up the trees crowding the river and creek banks in building their traditional log houses. The next alternative, one that made homesteading on the plains a possibility, was the earth, the sod, or "Nebraska marble." And for thirty years the standard on the plains was the sod house. (How sod came to be used as a building material is uncertain. The settlers may have borrowed the idea from the Mormons, who began building with sod in the mid-1850s. The Mormons, in turn, probably got the idea from the earth lodges of the Omaha and Pawnee Indians.)

Today we make every effort to design houses that bring the out- doors indoors and take the indoo out-of-doors. Patios serve as dini rooms; huge windows provide the lusion that we are outside when are inside. We open the house wa and break down barriers. But f nineteenth-century plains dwelle perceptions were different. After day of being squeezed between s and earth, of being exposed to t withering sun or a razor-sharp win there was little desire on the part the pioneers to bring the environme into their houses.

The house was meant to be fortress, a bastion for shutting out t outside. The thick walls, the fe small windows and close rooms we not seen as disadvantages—as th might be now—but rather as an int

l part of the sod house's advan- es. Far from being discomfited by cramped quarters, plains settlers ght the closeness of family mem- s in the evening hours, after a day nt out of sight and hearing of each er or, for that matter, of any other nan being. The close contact and ociation with the family took on a y special, desirable quality.

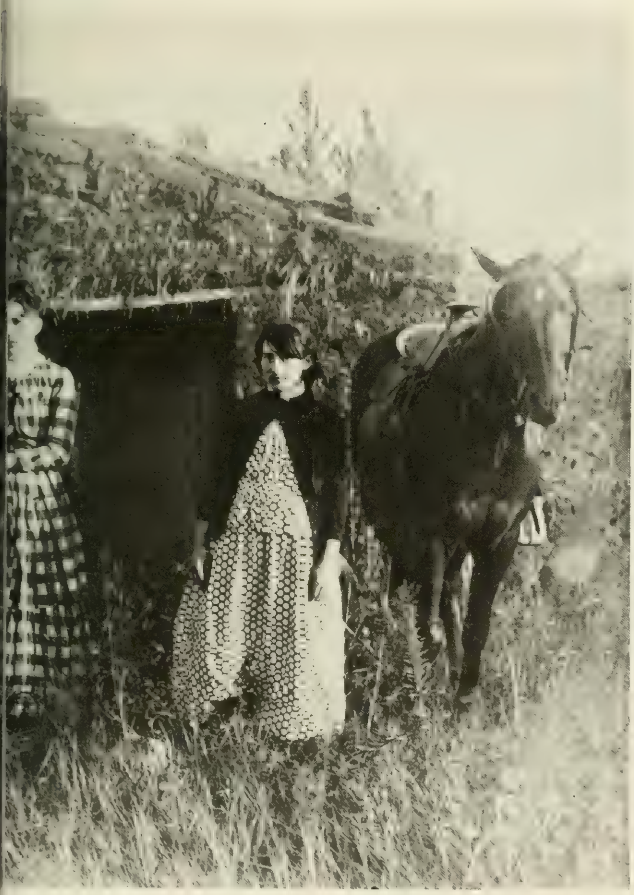
Writers' words resound with oes of this premise. To be sure, settlers saw the plains as a source vealth, but the riches could be won y by facing nature. The plains, h their promise of treasure and edom, demanded an ardent suitor, willing to face tasks and trials ch like those required of fairy-tale oes in their quest for a princess- de. The land was an adversary, an enemy, to be conquered and tamed. Sod was first and foremost an expedient response to plains geography. It not only answered the absence of conventional building materials but also countered the problems of heat, cold, wind, and defense. The two- to three-foot-thick walls kept the sod house warm in the winter and cool in the summer. Neither wind nor bullets could pass through them. Grass fires, a constant threat, would sweep by the soddies, singeing the door and window frames but leaving the interiors cool. Inside the cavelike buildings, the roar of the wind and thunder was only a faint murmur.

The settlers usually built their sod houses on a slight rise or hillside, never in a lowland or valley bottom where a spring flood might destroy them. They first leveled out a floor area with spades, then wetted and tamped it solid with a fence post or wagon tongue. This was the only foundation the house would have.

Moist bottomlands produced the best sod. Here the grass was toughest and the soil was more likely to hold together during the processes of cutting, moving, and house construction. Preferred grasses were buffalo grass (*Buchloë dactyloides*), cordgrass (*Spartina pectinata*), and big bluestem (*Andropogon gerardii*). Only enough sod for a day's work—about a quarter acre—was cut at one time so that no sod would lie in the open overnight and dry out. A standard 12- by 14-foot soddie required about one acre of sod. Wherever possible, oxen were used to cut sod because they gave a smoother pull on the plow than horses, which tended to lurch under the heavy task.

The tool used for cutting sod was not the conventional farming plow, the purpose of which was to tumble and break up the soil. Rather, a grasshopper plow, which had a horizontal blade, was used to shave away a ribbon of sod, three to four inches thick and eighteen inches wide, which passed smoothly over a rod moldboard and rolled over upside down behind the plow. Workers used sharp spades to cut this ribbon into "bricks" about two feet long. The bricks were then loaded onto a wagon or sledge and hauled to the house site.

The bricks formed the walls and were laid up grass-side down (for reasons I have never been able to discover) without any sort of mortar. To increase their stability and discourage tunneling by mice or snakes, the bricks were staggered. When the walls reached a height of two to three feet, simple board frames for the door and windows were set in place and propped with sticks. The rest of the walls then went up around them. Later, dowels were driven through



A remarkable number of women, singly or in groups, homesteaded during the nineteenth century. The Chrisman sisters, left, settled in this Nebraska sod house.

the frames and into the walls to hold the windows in place.

The slightly pitched roofs were made of from three to five heavy cedar beams, running from gable to gable on each side of the building. Over these beams the builders laid willow or cottonwood rods from peak to eave. Chokecherry or plum brush, then a layer of long grass—usually bluestem or prairie cordgrass—and finally, a layer of sod bricks followed. Here the sod was laid grass-side up so it would continue to grow and hold the roof together.

This early, expedient form of dwelling, often as much cave as house, had severe shortcomings, however. As the lyrics of "Starving to Death on a Government Claim," a folksong of the period, depict it,

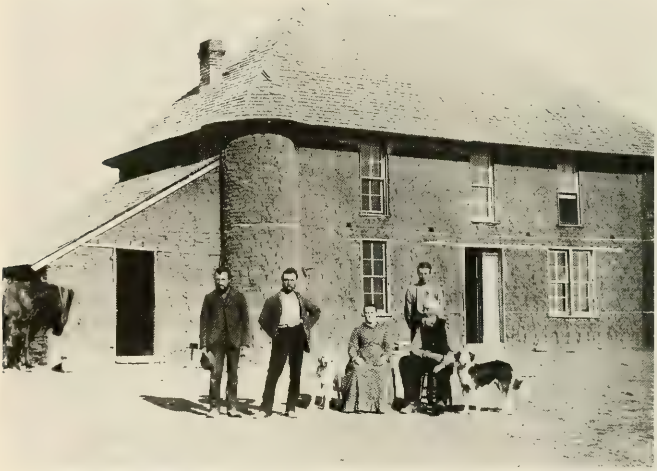
> My house it is built out of
> national soil,
> The walls are erected according
> to Hoyle;
> The roof has no pitch, it is level
> and plain,
> But I never get wet—unless
> it happens to rain.

Even after a rain had ended, water from the thick sod roof would continue to drip inside a house for several days.

Before many years this *ad hoc* house type began to undergo the polishing processes of tradition. A technology of sod construction quickly developed; within twenty years it had transformed the miserable sod hovel into the sometimes elegant sod home. The walls of these more elaborate dwellings were shaved with a spade, giving them clean, sharp lines. Window frames were slanted to permit more light to come through. Commercial or homemade plaster and stucco covered the house inside a
out to increase its durability and
duce a major problem of s
houses—fleas. These insects infes
the porous walls and plagued t
occupants.

Windows, the most expensi
component of the house (and one
quired by many homesteading law
often cracked or broke with the u
even settling of the heavy wal
Builders ingeniously solved the pro
lem by leaving a four- to six-inch g
above the window during co
struction. This space was stuffed w
paper or grass; as the walls settle
the gap simply closed.

Leaking roofs—the perpetual ba
of sod houses—were made watertig
either by adding a layer of plaster
the thatch under the roof sod or
using commercial cedar shing
brought in by railroad. Most hous
still retained a sod covering over t



This sod "château" was erected at a cost of $500 by a Belgian-French family that settled in Nebraska in 1884. As testimony to the durability of sod, this building—with its three-foot-thick walls—stood until 1973. when it was razed.

Settlers often used hillsides for the back walls of their sod houses. Folktales mention that some travelers, who came upon these houses while crossing the plains at night, believed that the voices coming from the chimneys issued from hell.

ngles for insulation and to add
ough weight to hold the roof on
ing high winds.

At the end of the nineteenth cen-
y, the suitability of the sod house
plains conditions became most ap-
ent. The Nebraska State Historical
ciety's photographic collection of
l houses reveals ample amounts of
lled lumber lying near the dwell-
s. Those who had settled on the
ins during the early part of this
ntury told me that while frame con-
uction was fine for animals, sod
s best for people. Wood burns,
s, warps, swells, and shrinks; in-
ts and mice chew through it; and
cold penetrates it. The large num-
of still standing, and frequently
l occupied, sod houses that are
y to eighty years old offers further
stantiation of the durability of
l.

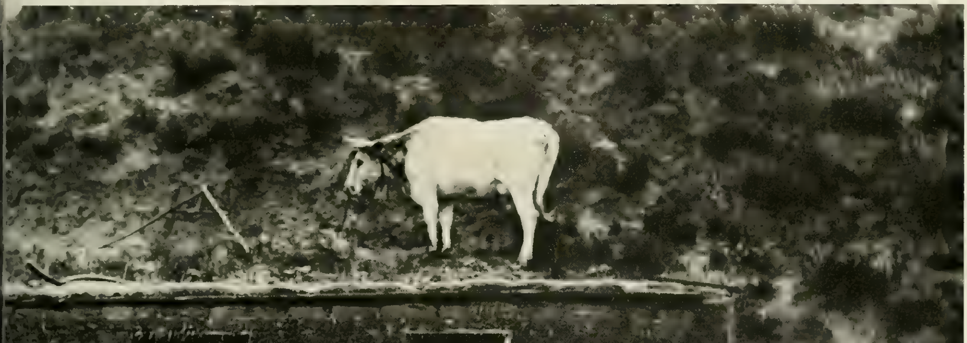
Why then did plains dwellers almost universally abandon sod for frame construction during the late nineteenth century? The primary cause was class consciousness. Those who had achieved financial security could advertise their success through the frame house.

As another reason, the initial impact of plains geography had begun to wear off. As a familiar plains' line goes, "Living in Nebraska is a lot like being hanged: the initial shock is a bit abrupt but once you hang there for a while you sort of get used to it." In the demise of sod houses, the forbidding mystery of the plains had dissipated to the extent that inhabitants no longer felt the need for the physical and psychological security that these dwellings offered.

Sod houses still dot the plains. Some are still lived in, but most are just derelicts—abandoned, their roofs overgrown, their door and window frames sagging. These ghosts, however, are more than merely abandoned houses. They are reminders of the grip the plains had on their early settlers. Behind their dark sod, these houses offered protection from a lonely and inhospitable land. They also offer another reminder—their abandonment and replacement by wood frame houses are symbolic of a reversal in attitude. Now, it appears that plains dwellers have a grip on the land instead of the other way around. Thus the sod house was as much a product of the impact of the plains on the human mind as it was a product of the geography of the plains.

A farmer friend of mine commented a short time ago, "We seem to forget that we may have made this land what it is, but first it made us what we are."

It also made the plains' houses of our parents and grandparents. ☐



On my way home from Borneo in 1966, I got as far as Laos, where I remained for more than three years plying the trade of capturer and exporter of wild animals. I very soon discovered just how lucrative a trade it was; the demand was always far greater than the goods available. I behaved neither better nor worse than my competitors. I merely copied their methods: to catch as many animals as possible and sell them at the highest price without bothering too much about various legal technicalities. In my own way, I was fond of animals; but it was a misconceived fondness, as is the case with many hunters and animal lovers.

By 1968 my business had become one of the biggest in Southeast Asia. I employed upward of a hundred trappers and a similar number of beaters and factors, and I had agents working for me on four continents. By wheeling and dealing, I had achieved a virtual monopoly of the trade in gibbons and some rare species such as the serow, clouded leopard, black leopard, and douc monkey.

In order to impress my customers and to be in a position to charge exorbitant prices, but partly also for the sheer fun of the thing, I dubbed myself Doctor of Natural Science and Veterinary Surgeon. And, in the same vein, I christened my business the Laos Biological and Experimental Centre.

For me there was no sudden change of heart, no road to Damascus. Let me merely say that there came a time when I began to ask myself questions, for example, when I found myself compelled to kill animals I was fond of, animals I had become attached In 1970 I set off on a tour of my m customers—zoos and circuses. W that journey revealed to me was t 80 percent of the animals I h dispatched had died either in tra or during the first few months of c tivity.

But it is no light matter to give a job that brings in a great deal of e money, and it was not until so months later that I finally made up mind to do it. I continued to recei orders, however, and my reply w to send my customers the followi letter: "I am sure that, as the cura of a zoological garden, you must a true animal lover; you will theref be delighted to hear that your mon has been used to purchase ten ad gibbons which I immediately leased into the forest." J.-Y.

Confessions of an Animal Trafficker

by Jean-Yves Domalain

There are trades in which
it is impossible for a
man to be virtuous
Socrates

Ninety percent of the animals that dealers display have passed along an interminable chain—the chain of trafficking—that links the producer to the consumer. When I use the word "trafficking," I take it as the dictionary meaning that defines it as "trading of a more or less clandestine, shady, and illicit nature."

Every year several thousands of tons of animals find their way from the jungle into captivity. This drain of wildlife is readily explained: the last thing the traffickers are lacking in is ingenuity and the financial stakes are so high that corruption inevitably results, especially in the countries in which the animals originate. The resources available to the inspection services are ludicrously inadequate or, in some areas, nonexistent.

In many countries the authorities are hardly concerned about the animal kingdom. The supervision of forests receives much more attention since the interests of large timber-felling concerns are involved. Let there be no misunderstanding: it is not that the forests are actually protected, but their exploitation is carefully supervised. Which means that felling and exploitation licenses bring in tidy sums that quietly find their way into numerous bank accounts, whether in Switzerland or elsewhere, totaling amounts that would cause considerable surprise if generally known.

The man who actually captures wild animals is usually a poor peasant hunter-trapper who sells his catch for very little. A casual glance at a general map of the areas from which the animals are drawn reveals that they are commonly situated in underdeveloped countries, where rules and regulations, if any, are loosely applied. The local trapper operates for the most part without the slightest anxiety. While in some areas vague rules and legislation could be garded as hampering his activiti the extent of the areas prospected, t inadequate resources available to t gamekeepers, and the widespre willingness to turn a blind eye me in fact, that the rules and regulatio remain a dead letter.

The peasant hunter understan only one thing, game catching, but has, in fact, no great understandi of it. He cares little if he catches pregnant female, a nursling that he neither able nor willing to feed, o member of an almost extinct speci On the contrary, the rarer the anim the more valuable and the easier find a buyer.

Everything is grist to the peas

Gibbons do not make good pe
yet there is a flourishing dema
in Europe for these primat
To capture young gibbons, hunt
usually shoot the mothe

Edmund Appel, Photo R

From *The Animal Connection*, by Jean-Yves Domalain, to be published by William Morrow & Co., Inc. English translation copyright © 1977, by William Heinemann Limited.

The international zoo trade still traffics in the endangered orangutan. Many captives become obese because of improper feeding and lack of exercise.

Kenneth W. Fink, Photo Researchers

ter's mill. The man who is putting he capital has promised to buy hing that moves, since anything moves can be sold, including the t unlikely creatures: frogs, wild- , snakes, birds, elephants, dol- ns, whales, fish, coral polyps, ns, and so on. Even insects, scor- ns, and spiders cannot escape this orable plundering of the fauna of y continent and every latitude.

he native—a highly skilled ter as far as hunting to kill is con- ed, whether it be by bird traps, traps, pitfalls, or plate traps— ws regrettably little about tech- ues of live capture. Trapping for ure is a subtle and dangerous —dangerous, that is, for the ani- s, since the trapper runs no great —and requires far more skill than immediate slaughter of game. A per must possess exceptional ers of observation, know every- g there is to know of the habits ild animals, be fully versed in the niques of setting traps, and most ortant of all, be capable of keep- his victims alive while waiting to patch them to the dealer. It is a rare g to find a native endowed with these gifts.

Mortality is high at the time of cap- . The native does a great deal of age to his catches through igno- ce and incompetence, but mainly, ough lack of concern. The reticu- d python, which measures be- en ten and twenty feet long, is ght in a running knot on the end a pole. Rather than use a thicker e, the Thai or the Baule or the Se- o chooses a piece of thin wire that s deep into the flesh of the neck. quently the reptile's mouth is tly bound with a second piece of e. The animals brought in often r wounds inflicted by a machete.

Why does the native trapper, who killed in the use of staked pits for opard to impale itself on, not use imilar pit, somewhat deeper and without stakes, in which to capture the animal alive? There is no rational explanation. He simply prefers the deadly trap that invariably mutilates the animal. On several occasions I have been sent big cats that had been caught uninjured but had subsequently had their four paws tied tightly together with barbed wire. One of these reached me after more than ten days of unimaginable distress and died soon after, the extremities of its limbs appallingly affected by gangrene.

Pangolins, toothless, scaly mammals that feed on ants and termites, are habitually prevented from escaping by having a hefty carpenter's nail driven through their tails. This is an animal with very powerful claws—capable of smashing in termite nests—and no ordinary cage, especially a wooden one, is proof against it; consequently, it is nailed to the floor. Only very rarely have I received an uninjured specimen.

After trapping, much brutality is used in getting the animals into crates, especially when the creature involved is dangerous or believed dangerous. A blow over the head with a club is still the most frequently employed method. It is undoubtedly effective but inevitably damaging.

Many species are treated even more brutally: the mother is killed in order to get at the baby. Sometimes three or four females have to be killed before an infant not badly injured is secured. The risk of things going wrong is enormous; the baby may be unintentionally shot or break its neck or its limbs in falling; or again, if the wounded mother runs away and dies in some inaccessible spot, the baby may go on clinging to her and slowly starve to death. Newborn monkeys never survive; even the older ones rarely emerge from the ordeal unscathed and are often left with a hail of shot lodged deep within their bodies.

Land clearance and deforestation are among the most cost-effective methods of capturing young animals. Setting fire to the undergrowth is another commonly employed, but deadly, technique since slow-moving animals and, above all, baby animals are roasted alive in considerable numbers.

Big-scale organized hunts, as shown in popular films, are still a rarity. They are, generally speaking, organized by specialists and rely upon well-trained and supervised local talent. The companies organizing such hunts go for the "big stuff": elephants, zebras, giraffes—monkeys when there is a major order for them. They enjoy legal status and on the whole abide by the regulations. Modern methods of beating (radio communication, spotter planes, motorized transport) and the use of hypodermic tranquilizer guns cut down losses considerably, although accidents still happen, usually due to mistakes in the drug doses administered. Once the capture has been completed, men with scientific or parascientific training and a sound veterinary grounding are put in charge of feeding and caring for the animals. As far as I can determine, it is only in east Africa that such companies exist; everywhere else animals are hunted on an individual basis by the indigenous population.

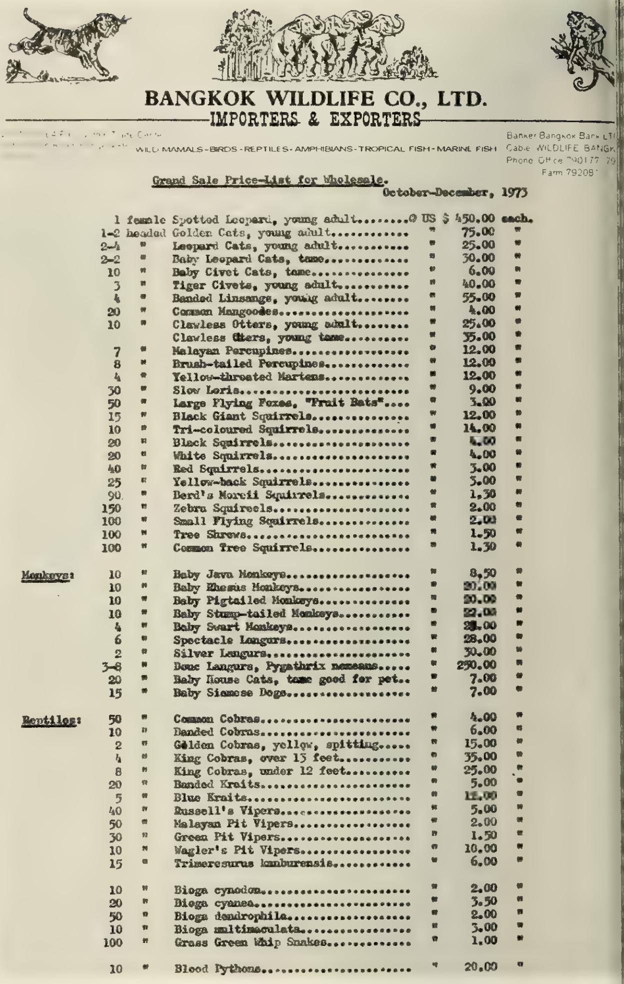
It sometimes happens that an entire village organizes a large-scale netting operation. This involves encircling a large area with a net held in position with stakes and driving primates (gorillas, macaques, and baboons), antelopes, and so on into its meshes. It is a very profitable method of hunting, but as no provision is made to house the numerous animals captured, they stay tied up on the spot until sold.

There is another profit to be made by the hunters and trappers—from dead animals. Pelts, ivory, feathers, teeth, paws, hooves, horns, and tails—they sell the lot, along with organs deemed to possess medicinal properties, such as the eyes, the liver, the heart, the tongue, and the testicles, which acquire, after appropriate prayers have been mumbled over them, magical or aphrodisiac qualities. Reptiles, in particular, figure prominently in these commercial bargainings, but whenever there are too many of them on offer or customers are hard to find, they are skinned without further ado, often still alive.

In the next step of the chain, the animals go to the local pickup man. He is sometimes a native, sometimes a "poor white" who has ended up in this backwater, like some pitiable survivor in one of Conrad's novels.

outdoor bird market in Brussels, gium, does a brisk business. gbirds are popular pets in ope: some species are bred; ers imported illegally.

n, Photo Researchers



The "grand sale" price list of a leading Thai supplier gives a hint of the number of animals involved in the trade. Because orders are fewer in winter, prices are low.

BANGKOK WILDLIFE CO., LTD.

IMPORTERS & EXPORTERS

WILD MAMALS - BIRDS - REPTILES - AMPHIBIANS - TROPICAL FISH - MARINE FISH

Banker Bangkok Bank LT
Cable WILDLIFE BANGK
Phone Office ?90177 79
Farm 79208

Grand Sale Price-List for Wholesale.

October-December, 1973

	1	female	Spotted Leopard, young adult........	@ US $	450.00	each.
	1-2	headed	Golden Cats, young adult............	"	75.00	"
	2-4	"	Leopard Cats, young adult...........	"	25.00	"
	2-2	"	Baby Leopard Cats, tame.............	"	30.00	"
	10	"	Baby Civet Cats, tame...............	"	6.00	"
	3	"	Tiger Civets, young adult...........	"	40.00	"
	4	"	Banded Linsangs, young adult........	"	55.00	"
	20	"	Common Mangoodes....................	"	4.00	"
	10	"	Clawless Otters, young adult........	"	25.00	"
			Clawless Otters, young tame.........	"	35.00	"
	7	"	Malayan Porcupines..................	"	12.00	"
	8	"	Brush-tailed Porcupines.............	"	12.00	"
	4	"	Yellow-throated Martens.............	"	12.00	"
	30	"	Slow Loris..........................	"	9.00	"
	50	"	Large Flying Foxes, "Fruit Bats"....	"	3.00	"
	15	"	Black Giant Squirrels...............	"	12.00	"
	10	"	Tri-coloured Squirrels..............	"	14.00	"
	20	"	Black Squirrels.....................	"	4.00	"
	20	"	White Squirrels.....................	"	4.00	"
	40	"	Red Squirrels.......................	"	3.00	"
	25	"	Yellow-back Squirrels...............	"	5.00	"
	90	"	Berd's Moreii Squirrels.............	"	1.30	"
	150	"	Zebra Squireels.....................	"	2.00	"
	100	"	Small Flying Squirrels..............	"	2.00	"
	100	"	Tree Shrews.........................	"	1.50	"
	100	"	Common Tree Squirrels...............	"	1.30	"
Monkeys:	10	"	Baby Java Monkeys...................	"	8.50	"
	10	"	Baby Rhesus Monkeys.................	"	20.00	"
	10	"	Baby Pigtailed Monkeys..............	"	20.00	"
	10	"	Baby Stump-tailed Monkeys...........	"	22.00	"
	4	"	Baby Swart Monkeys..................	"	2[illegible].00	"
	6	"	Spectacle Langurs...................	"	28.00	"
	2	"	Silver Langurs......................	"	30.00	"
	3-8	"	Douc Langurs, Pygathrix nemeans.....	"	250.00	"
	20	"	Baby House Cats, tame good for pet..	"	7.00	"
	15	"	Baby Siamese Dogs...................	"	7.00	"
Reptiles:	50	"	Common Cobras.......................	"	4.00	"
	10	"	Banded Cobras.......................	"	6.00	"
	2	"	Golden Cobras, yellow, spitting.....	"	15.00	"
	4	"	King Cobras, over 13 feet...........	"	35.00	"
	8	"	King Cobras, under 12 feet..........	"	25.00	"
	20	"	Banded Kraits.......................	"	5.00	"
	5	"	Blue Kraits.........................	"	12.00	"
	40	"	Russell's Vipers....................	"	5.00	"
	50	"	Malayan Pit Vipers..................	"	2.00	"
	30	"	Green Pit Vipers....................	"	1.50	"
	10	"	Wagler's Pit Vipers.................	"	10.00	"
	15	"	Trimeresurus kanburensis............	"	6.00	"
	10	"	Bioga cynodon.......................	"	2.00	"
	20	"	Bioga cyanea........................	"	3.50	"
	50	"	Bioga dendrophila...................	"	2.00	"
	10	"	Bioga multimaculata.................	"	3.00	"
	100	"	Grass Green Whip Snakes.............	"	1.00	"
	10	"	Blood Pythons.......................	"	20.00	"

Hot countries all have their quota of these white outcasts, rejected by both civilizations, who eke out a wretched existence. More often than not, they are to be found in the hutments of the slum areas, but occasionally some take to scouring the lowlands and set themselves up as animal dealers. They tend to be concentrated in townships on the skirts of the forest and they are willing to take anything the peasant hunter-trappers bring in. Their task is a simple one: to recruit local peasants whose entire catch they will subsequently buy. All they then have to do is to store the animals until the exporters from the capital come out and collect them. In Thailand there are about twenty collection points scattered throughout the country, although the southern forestlands provide the greatest amount of game. Some game collectors employ up to a hundred villagers.

The collector's decrepit premises are entirely inadequate. Since profits at this point in the chain are very low, the fellow is unwilling to spend a single penny on animals that are merely passing through his hands.

For a gibbon in good shape, that is, with no visible injury, the peasant gets between $10 and $14. The collector gets about $30 from the exporter, who immediately ups the price to $200. When it comes to the European or the American importer, he really makes a killing. The eventual purchaser may have to fork out more than $400 for a monkey valued at $10 at the outset. The fact is, then, that it is the exporters and importers, that is, the middlemen, who make the biggest profits. Their expenses, especially those of the exporters, are negligible: local employees, even if they are incompetent, at least do not cost much, and food for the animals is cheap and dispensed very sparingly. The importer, on the other hand, does have to pay the air freight charges; but even so, these two last links in the chain do very well for themselves.

Birds are a particularly profitable proposition and are, moreover, ordered in large numbers. A consignment of three thousand myna birds is by no means exceptional. A myna, which brings a mere $.60 to $1.00 to the peasant, is sold for at least $30 by the wholesaler. Those sold as talkers, or that even show promise in that direction, fetch much more. On the Quai de la Mégisserie in Paris, it is common for the larger varieties of myna to fetch more than $300, a figure that takes some stomaching when one is aware of what the birds originally cost. It is true that the wastage is considerable, but it is amply co pensated for by the staggering pr margins.

While it is possible to plead ext uating circumstances for the po uneducated hunters, who scarc earn enough to keep body and s together, the middlemen stand out mean, grasping creatures worthy neither pity nor regard. The traffickers, who have never set foot either jungle or savanna, are nothi but mean-minded, acquisitive, scrupulous tradesmen.

It is common practice for deal to revamp their animals in order make them look presentable. It is

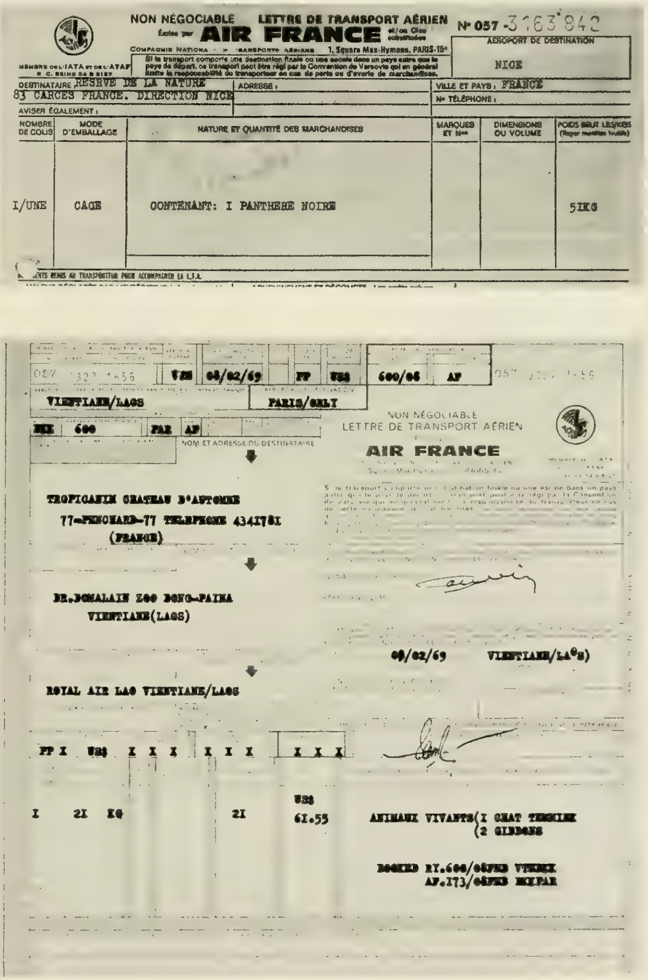
old con, familiar to horse traders
airgrounds. In the trade they call
giving them a new lease on life.''
otter whose fur is on the pale side
uddenly transformed into an al-
with the aid of some hydrogen
oxide, with a consequent increase
alue from $30 to $1,000. Snakes
ering from fungal growths are
eaned up'' before being pack-
d; all that is necessary is to scrape
the caseous magma, thus making
creature presentable for the few
s required to sell it. Some leop-
are transformed into black leop-
with a coat of paint. I remember
that did not survive the experi-
: they licked off the toxic sub-
ces that had been sprayed over
r fur. Another frequently em-
yed con consists of dyeing dull-
red birds.

onsieur Saravan, of the French
nal import firm Prexotical, re-
led some of the tricks of the trade
ne, the sharpest of which was in-
utably the operation he regularly
formed on dromedaries. Drome-
ies are expensive to buy but easy
reed. So some fellows out for the
atest profit bought several pairs in
er to start a stock farm. They were
prised to find the animals sterile.
would advise the unfortunate
eders to have the testicles of their
le camels carefully examined;
y will discover that they have been
shed by clapboards. This form of
tilation is very difficult to detect,
n by touch, and enables the dealer
at least double his sales of male
medaries, as single-minded
nts go on buying more and more
reeding animals.''

The same trick is used in all cases
ere castration is easy: ungulates,
ds, and so forth. One trader, who
d a few years ago, used to expose
all mammals to massive doses of
aviolet rays in order to achieve the
ne result.

Another shabby device used by the exporter to make a bit more money is the practice of substituting one animal for another. The middlemen always play dumb to achieve their ends, and under the pretext of ignorance—which is often genuine—they dispatch goods only very remotely corresponding to the order placed—for example, a common green pigeon (*Treron curvirostra*) instead of a Nicobar pigeon (*Caloenas nicobarica*). The ''mistake'' can be even more spectacular: it is no rare thing to find a leopard cat (*Felis bengalensis*) that weighs nine pounds at the outside ''muddled up'' with a leopard. The not-too-bright purchaser believes he has acquired a baby leopard and, as the months go by, is surprised at how slowly the little creature seems to be growing. The animal dispatched, in fact, costs only $160, whereas a ''tamed baby leopard'' can fetch as much as $1,000 when sold retail.

Like everyone else, on a number of occasions I off-loaded ''rubbish'' that had been left hanging about unsold in my cages. The usual way I did so was by playing with words; for example, the Prexotical firm one day received a crate from Vientiane containing four Temminck's cats, whereas according to the terms of the contract



NON NÉGOCIABLE LETTRE DE TRANSPORT AÉRIEN
Émise par AIR FRANCE et/ou Cies substituées
COMPAGNIE NATIONALE DE TRANSPORTS AÉRIENS 1, Square Max-Hymans, PARIS-15e
MEMBRE DE L'IATA ET DE L'ATAF
R. C. SEINE 54 B 8187
Si le transport comporte une destination finale ou une escale dans un pays autre que le pays de départ, ce transport peut être réglé par la Convention de Varsovie qui en général limite la responsabilité du transporteur en cas de perte ou d'avarie de marchandises.
N° 057 -3163842
AÉROPORT DE DESTINATION: NICE
DESTINATAIRE: RESERVE DE LA NATURE
83 CARCES FRANCE. DIRECTION NICE
ADRESSE:
VILLE ET PAYS: FRANCE
N° TÉLÉPHONE:
AVISER ÉGALEMENT:

NOMBRE DE COLIS	MODE D'EMBALLAGE	NATURE ET QUANTITÉ DES MARCHANDISES	MARQUES ET Nos	DIMENSIONS OU VOLUME	POIDS BRUT LBS/KGS (Rayer mention inutile)
I/UNE	CAGE	CONTENANT: I PANTHERE NOIRE			5IKG

DOCUMENTS REMIS AU TRANSPORTEUR POUR ACCOMPAGNER LA L.T.A.

057 327 1656 VTE 08/02/69 PP US$ 600/06 AF 057 327 1656
VIENTIANE/LAOS PARIS/ORLY
BKK 600 PAR AF
NON NÉGOCIABLE
LETTRE DE TRANSPORT AÉRIEN
AIR FRANCE
NOM ET ADRESSE DU DESTINATAIRE

TROPICANIM CHATEAU D'AUTOMNE
77-PENCHARD-77 TELEPHONE 4341781
(FRANCE)

MR.BOUALAIN ZOO DONG-PALMA
VIENTIANE(LAOS)

08/02/69 VIENTIANE/LAOS)

ROYAL AIR LAO VIENTIANE/LAOS

PP X US$ X X X X X X X X X

I 2I KG 2I US$ 6I.55 ANIMAUX VIVANTS(I CHAT TEMMINK
(2 GIBBONS

BOOKED RY.600/08FEB VTEBKK
AF.173/08FEB BKKPAR

Waybill confirms the author's hipment of a black panther from Laos to France. Many animal cargoes are illegal, but bribery and false documents get them through the customs.

of sale they were expecting four golden panthers. To give some idea of how ignorant these people were, although they were France's biggest importers of wild animals, I have to admit that the golden panther does not exist, save in the price list I had carefully compiled for Prexotical. I had, however, taken the elementary precaution of stating a precise scientific name for the cats. Thus, golden panther was *Felis temmincki*—you had to be pretty stupid to fall for that to the tune of 2,000 francs ($400), an exorbitant price, since *Felis temmincki*, or golden cat, bought anywhere else was worth only 200 francs ($40) wholesale. Only the extreme rarity of my golden panthers enabled me to put such a price on them. I might add that this objectionable firm found customers for my fabulous beasts even before taking delivery of them and, in fact, sold them as golden panthers.

I have often received insulting letters from directors of zoos, complaining that the animals I sent them were not as ordered, although the order had been scrupulously filled. The person concerned had simply described the animal incorrectly or had made his list by referring to the *Larousse Encyclopedia*, a nonspecialist production that gives little idea of different species and their proportions.

Occasionally one comes across the reverse situation; someone obsessed with Latin terminology and subspecies. A fearful idiot, who runs a seedy little zoo in Brittany, insisted on being sent a subspecies of leopard cat that only exists in Formosa. I sent him a common leopard cat (*Felis bengalensis*) in first-class condition, in exchange for which I received abusive and even threatening letters.

Several weeks later I made him another proposition. I had a paralyzed wildcat in stock. Unable to bring myself to destroy the creature in cold blood, I had isolated it from the other animals and it lived a wretched existence in its own corner. I had no idea what to do with it, and it was out of the question to send it to an ordinary customer. But my man in Brittany was no ordinary customer so, after receiving one of his irate letters, I wrote him saying I was able to offer him a *Felis bengalensis* of the rare variety *hemiplegis*. Would he be interested in this unique specimen of its type, with which he, as a specialist in rare felines, must surely be familiar? Of course he was familiar with it, of course he was interested, and he agreed to pay the phenomenally high price I had asked!

The number of honest dealers is remarkably small. I am personally acquainted with about fifty exporters scattered over four continents. I have worked with all of them for many years, permanently or on and off, and I am utterly incapable of naming a single one who does not habitually employ such methods.

It sometimes happens that, in a given season, an animal's skin is worth more than the live animal itself. At such times, colobus monkeys are massacred in their cages if they fail to sell immediately, as they are delicate creatures, especially in captivity. Better a good healthy skin now than a substandard mopping-up cloth in a few weeks time.

In 1972 the Thailand Animal Company slaughtered three black leopards simply because they had no immediate buyers. It was the wrong season of the year, the beginning of winter in Europe and the United States, when no prudent zoologist will take on any exotic creature. The cost of feeding the animals would have eaten up all the profit, so they were poisoned, and their skins, rapidly cured, fetched more than enough to offset the original outlay. The same year an American of Austrian origin, working as a dealer in northern Thailand, shot a batch of four leopards with a pistol. The man, obliged to move to a new house on short notice, had calculated that the cost of moving would be too high for him. Even the Bangkok dealers were horrified. The jungle was at his doorstep; the animals could easily have been set free.

Deception is not practiced exclusively with regard to the quality of the goods dispatched, but also to the methods of dispatch. Permits, waivers, and other official documents are often forgeries from beginning to end. It is extremely easy to get hold of official forms. I myself simply used to have them printed. Then all one had to do was fill them in. Rubber stamps were not expensive and always made the right impression. In any case, even if the papers were genuine, the goods did not correspond.

Kenneth W. Fink, Photo Re

Clouded leopards, an endanger
species, bring high profits
dealers. The animals often endu
weeks in inadequate crates a
diets of sinew, bones, and f

What frontier or airport official
knowledgeable enough to sort c
prohibited species from the vast l
of animals that are allowed to lea
the country? Who could tell the d
ference between a flat-headed c
(*Felis planiceps*) and the comm
fishing cat (*Felis viverrina*)? Just
help matters, the names are alwa
written in English or Latin. The ve
nacular forms never appear in the re
ulations. As far as any petty offic
knows—and he is frequently illit
ate—the two cats referred to are co
pletely identical, especially if t
consignment notes and veterina
certificates confirm that they are bo
fishing cats.

The bribing of airport officials
equally common practice and,
though a somewhat costly way
going about things, is relatively sa
In Bangkok the going rate is $10 f
a gibbon and $100 for a Malay
tapir. In Bogota and east Africa t
scale of charges is similar. The co
rupt official takes delivery of the cra
and simply forgets to enter it on t
waybill. A certain amount of tact
required and, in the case of une
pected changes in duty rosters, pla
can go awry. When a big order is i
volved, it is necessary to resort
other means. Only international a
ports are supervised, and no serio
attempt is made to patrol each secon
ary road leading into a neighbori
country. All that is required is a ce
tificate of origin—stating, for i
stance, that a given chimpanz
comes from the Ivory Coast—a
veterinary certificates. At the front

Between time of capture a
arrival at final destinatio
birds and other animals suf
staggering mortality from rou
handling, crowding, and poor di

Jack Fields, Photo Re

Tom McHugh, Photo Researchers

Birds of the Psittacidae family harbor diseases transmittable to man, yet firms in Bangkok export thousands of parrots and parakeets without precautions.

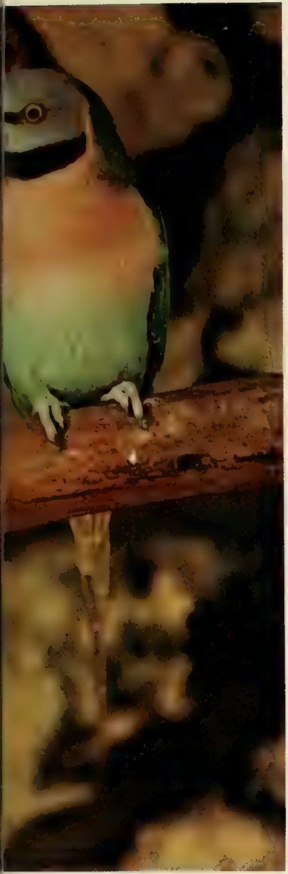
post in Upper Volta, the smuggler has his official papers stamped and states that his animals are merely in transit. The whole operation is thereby made official and there is no longer any problem in boarding a plane at Bobo-Dioulasso. It is surprising and illogical to find that in the Ivory Coast, as in many other countries, it is quite in order to keep animals in captivity although their export is forbidden. So dealers are able to hold in stock as many creatures as they like and no one subsequently inquires how their cages come to be empty.

Certain firms with impressive letterheads (Allied Institute of Applied Herpetology, Michigan Center for Research, for example) take advantage of an incredible obsession with official-looking documents, which is particularly widespread in underdeveloped countries and in France, to claim special treatment. The legal authorities would be greatly surprised were they to pay a visit to the premises of some of these research centers, for they would find not the slightest trace of scientific equipment. The impressive list of qualifications after the directors' names, although not authentic, suffices to instill confidence.

There are many countries in whi
the mere use of the title "zoo" is s
ficient to obtain special permission
export certain protected species. It
easy to understand how, under the
conditions, a set of forged docume
and rubber stamps is an essential p
of the office equipment of any se
respecting trafficker.

The last important person in t
chain of animal trafficking is the p
vate buyer. He is beyond question t
vital link, since without him this s
did trade would not exist. If peo
were well informed, they wou
never visit zoos and would certai
not purchase wild animals.

The number of animals livi
within the confines of our mode
cities is staggering. Some dangero
wild species are kept in apartments



ey were cats or dogs, and many
ntually end up in zoos, unless
etly put to death when they be-
e too much of a nuisance. They
ge from scorpions to hordes of
nkeys, the smaller carnivores,
tiles—a recent fashion that is
wballing—and, of course, fishes
birds.

)n the basis of the tons upon tons
nimals dispatched specifically to
ate individuals, it is reckoned that
he present moment there are, in
is alone, several score of big cats
thousands of snakes. Reference
the importers' books shows that
re than fifty thousand snakes enter
nce every year, while imports into
many, Belgium, and, more par-
larly, Holland exceed this figure
a wide margin.

What is the explanation of this extraordinary craze? I believe it is not so much due to a sudden passion for nature as to a fashion resulting in part from the large number of wildlife films and the publicity some of them have received. Many adults and children now want to have in their homes some of the animals they have admired in the wild state in such films, without realizing how serious a problem it is to keep them in captivity and, above all, that the practice is jeopardizing the survival of some species. While some films have made major contributions to the conservation of wildlife, they have also to some extent done indirect damage to the cause. We now have to convince the public that lions were never intended to live in a third-floor apartment, and that alligators prefer the marshlands of the Everglades to a bathful of chlorinated water.

It does occasionally happen that private individuals wish to enjoy the company of animals out of genuine and unselfish affection. But the damage done is still the same, since the wish of such people to have a pet has meant that at least ten others of the species lost their lives merely to satisfy this quirk for wildlife.

Asian snake charmers need a constant supply of fresh cobras. Native collectors capture large numbers of Indian cobras, below, to satisfy the demand.

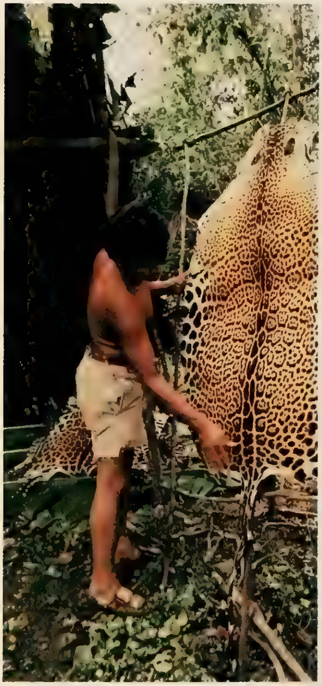
K H Switak Photo Researchers

In order to gratify his passion, whether it be merely a passing enthusiasm or more deeply rooted, the buyer does not hesitate to part with considerable sums of money: a talking myna bird, for example, generally brings between $180 and $300, according to how shrewd the buyer looks. But that is only the beginning. The cage to keep the bird in can cost $100, and that would be for a ludicrously inadequate one. And then there is the special food sold with the myna. Monkeys are much more expensive to buy and maintain. As for the big cats, they are absolutely ruinous: a clouded leopard now costs at least $3,000. Ocelots are greatly in demand, although the species is in danger of extinction in its native forests. An ocelot fetches about $800. But buying an animal is one thing; caring for it throughout its lifespan is quite another.

The smell of wild animals rapidly becomes unbearable, even if they are naturally clean. Many should be housed outdoors, which poses problems in the winter. Others require a higher ambient temperature than a human finds comfortable. Generally speaking, these creatures are exceedingly frail and need constant care and attention. Unfortunately, most veterinarians, used to dealing with cattle or with dogs and cats, are often incapable of diagnosing what is wro with a kinkajou or a monkey.

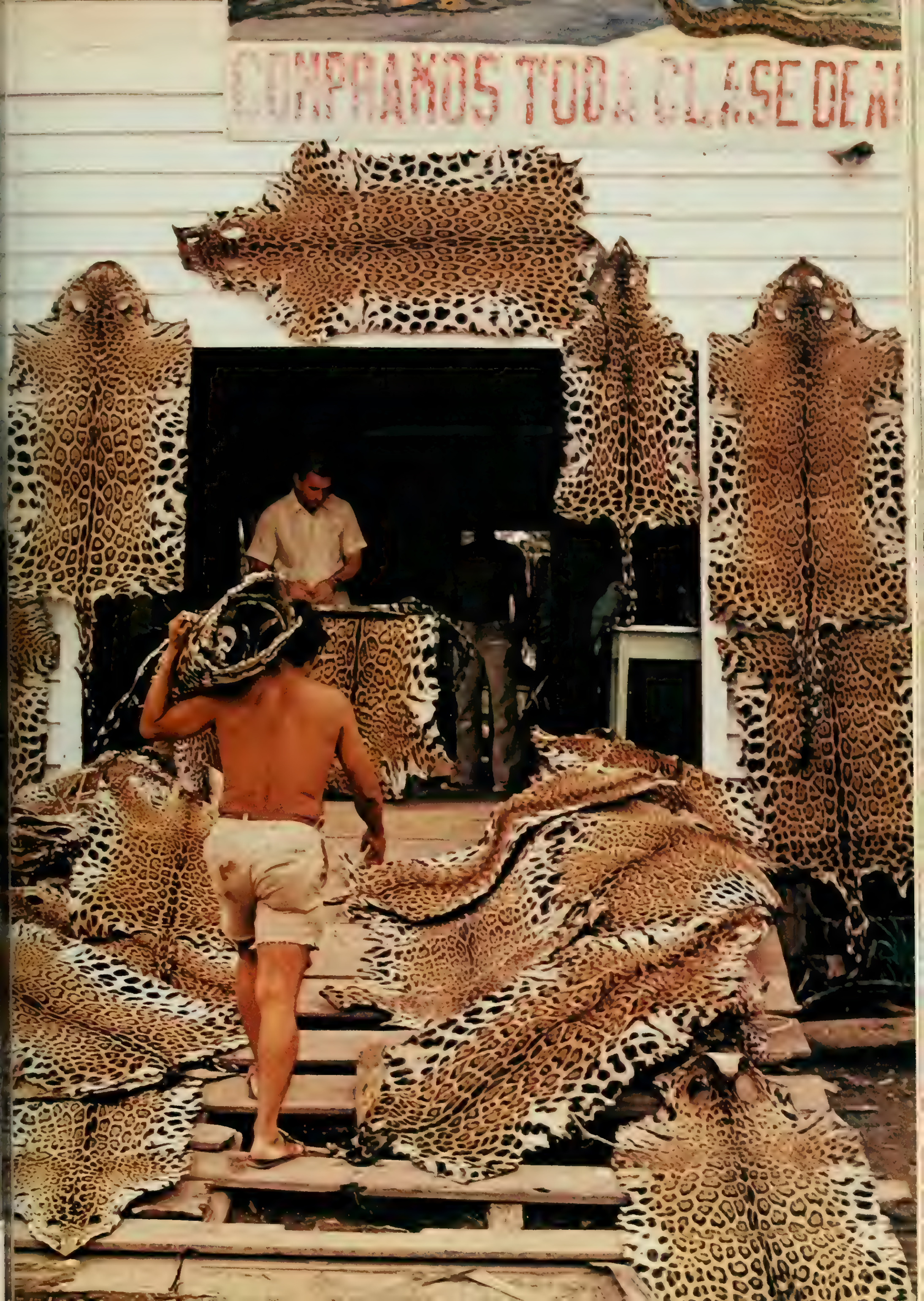
It should also be pointed out tl such animals, coming as they do fro tropical or equatorial countries, ca bacteria and parasites that are f quently transmittable, and sometim deadly, to man. Even apparen harmless birds may transmit virule diseases to humans, and children a particularly vulnerable to infecti from many internal or external pa sites carried by wild animals.

All these reasons should be su cient to discourage prospecti buyers of wildlife. But the most i portant remains the protection a preservation of animal species.



The skin trade is alive and well in countries such as Colombia. A native hunter stretches a jaguar skin, above, then rolls up his booty and transports it to a local dealer, far right. The dealer buys skins from many natives who cover a broad geographical area. Most of these skins will go to the European fur market; legislation has put a crimp in this trade in the United States.

Jonathan T Wright, Bruce Coleman,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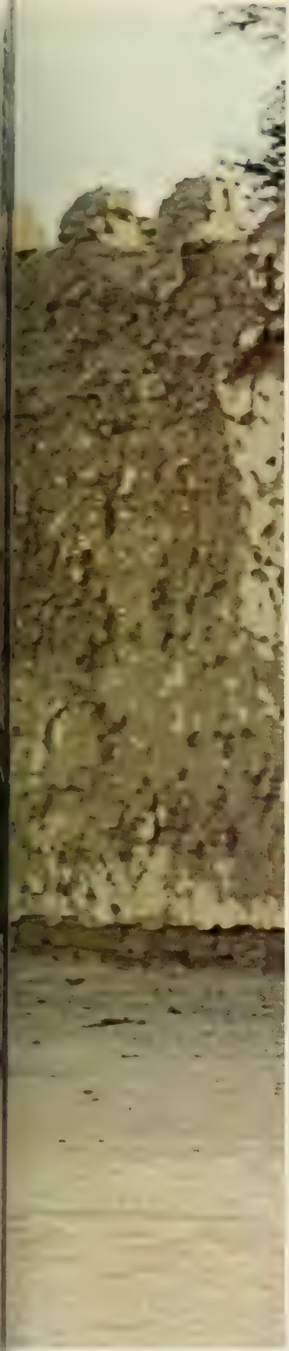


Fabulous Timbuktu

by Klaus-Friedrich Koch

> "Oh you who journey to Gao make a detour to Timbuktu, whisper my name to my friends and bear them sweet greetings from the exiled who longs for the soil on which his friends, and family, and neighbors live."
>
> *Wall inscription in the Centre Ahmad Baba, Timbuktu*

These lines were written—the legend goes—by Ahmad Baba when he saw a camel caravan leaving Marrakesh, in Morocco, for Gao on the Niger River, which it would reach after many weeks of hazardous travel across the Sahara.

The noble status of these visitors to Timbuktu is apparent by their fine robes and animals. Below, a tailor confers with a customer in one of the covered markets of the city.

Ahmad Baba had been a teacher at the famous Sankoré mosque and university of Timbuktu in the kingdom of Songhai when a Moroccan army conquered this Sudanic empire near the end of the sixteenth century. Suspected of encouraging a rebellion, Ahmad Baba was deported to Marrakesh. When he returned to his native city after twelve years in exile, Timbuktu had already begun its decline into the desolate town of mud-brick houses and grass huts that I saw on my visit in 1976.

The author of the travel guide I read on the small airplane that brought me to Timbuktu probably meant to spare me the disappointment other visitors had felt on reaching *la cité mystérieuse.* "As it is now," I read, "it would be thrilling to stumble on Timbuktu en route to somewhere else, but it can't bear the weight of a special trip."

It can indeed—for those who go to the edge of the Sahara to view the

ıants of a city that had once been ossroad of international com- :e and, during the fifteenth and :enth centuries, along with Cairo, and Damascus, one of the great ers of Islamic scholarship.

imbuktu's mystique is the appeal s magnificent past. Founded by ghai traders from the east and ıbara merchants from the west at site of an ancient summer camp ıe nomadic Tuareg, the city owes its rise to imperial splendor and ater decay to geography. Here, re the Niger borders the desert, routes out of western Africa ed up with trans-Saharan caravan s. When the caravans no longer e, Timbuktu sank back into the l from which it had emerged. The ges of many wars had brought the down from its exalted place in ieval Africa. When European ex- ers finally "rediscovered" this ıntis of the desert, they were sur- ed at what they found.

he man who originally put Tim- tu on the map as one of the busiest nd markets of the fourteenth cen- was Mansa Musa, ruler of the i empire that arose in the Upper er region at the turn of the thir- ıth century. Like the other em- s of the western Sudan (Ghana, ch it eclipsed, and Songhai, to ch it yielded), Mali derived its lth from the control of the trade es along which caravans moved vily taxed valuables: gold from tern Africa to the Maghreb and no less precious salt from the Sa- ı to the south.

Vhen Mansa Musa went on his pil- nage to Mecca in the year 1324, caravan—tens of thousands of ple, including five hundred es—transported many tons of l across North Africa. During his in Cairo as a guest of the sultan, nsa Musa's own lavish generosity the avarice of local merchants, cheated the black king in every l, temporarily depressed the price old in Egypt by 10 to 25 percent. laji Musa returned from Mecca with an Andalusian poet and architect he had met in the holy city and who now built him a palace and a new mosque, the Great Mosque, in Timbuktu. With the rise of the city's commercial importance grew the reputation of its schools, where widely known scholars taught history and science and Islamic jurisprudence.

Mansa Musa's extraordinary journey made his kingdom known throughout the Muslim world. In the 1350s the most illustrious explorer who ever lived, the Berber Ibn Batuta of Tangier (who had previously traveled in South and Central Asia, reached Peking, and seen Sumatra), visited Mali and later wrote about its people:

> The negroes have a greater abhorrence of injustice than any other people. Their sultan shows no mercy to anyone who is guilty of the least act of it. There is complete security in their country. Neither traveller nor inhabitant in it has anything to fear from robbers or men of violence.

Such tranquillity did not last long. By the end of the fifteenth century, disputes over dynastic succession and battles with the encroaching Mossi of the upper Volta River had weakened the empire. For Timbuktu, a brief period of Tuareg domination ended in A.D. 1468 with the invasion of the Songhai forces from Gao, where a hundred years earlier a kingdom had begun to form that later extended from Lake Chad to the Atlantic Ocean. Following the erratic rule of Sonni Ali, the conqueror who murdered a great number of the city's learned men and favored others of his choice, the fame of Timbuktu's teachers spread again under the reign of Muhammad Ture, later known as Askia the Great, one of Ali's commanders who had usurped regal power from Ali's son within a year of his father's death. Askia the Great was a patron of the arts and sciences and during his reign, the Sankoré qadis (judges) achieved international recognition as authorities in Islamic law. The libraries of Timbuktu's scholars included works from all branches of learning. Catalogs that have survived list ethnographies and chronicles, grammatical treatises and theological commentaries, legal texts and books on astronomy and medicine.

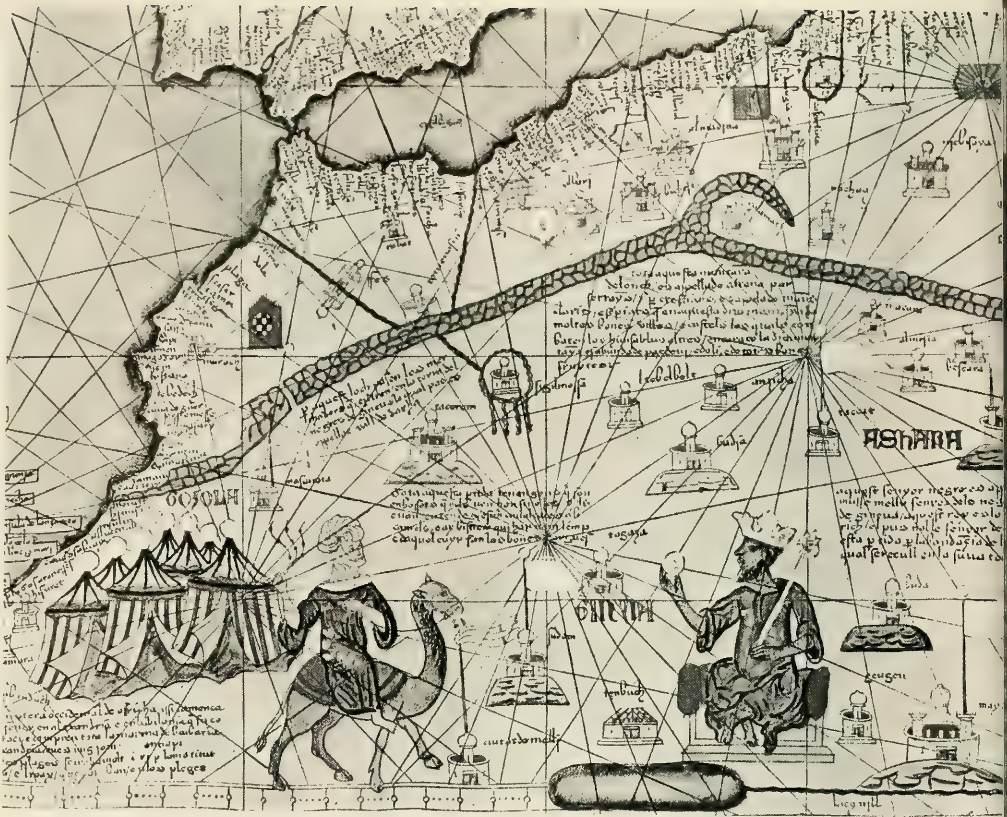
Until the modern-age explorers reached the Niger in the late eighteenth and early nineteenth centuries, most things known in Europe about the Sudan came from a remarkable work that was first published in Venice in 1550 and appeared in an English translation in London fifty years later. Its title was *The History and Description of Africa and of the Notable Things Therein Contained,* written by Al-Hassan ibn Muhammad, better known as Leo Africanus. Hassan was born in the mid-1460s in Granada but he grew up in Fez, Morocco, where his family had joined the large community of Moorish emigrants from Christian Spain. After many years of travels throughout the Muslim world he was captured returning from a trip to Egypt, when Christian pirates seized his ship off the coast of Tunisia. Impressed with his learning, his captors delivered him as a servant to Pope Leo X. The pope, however, baptized the Moor and granted him his own name. Living off a papal stipend, Leo Africanus, who had visited Timbuktu when Askia the Great reigned over the city and it was at its zenith, recorded his knowledge of the interior of Africa.

> Here are many shops of artificers, and merchants, and especially of such as weave linnen and cotton cloth. . . . The inhabitants, and especially strangers there residing, are exceeding rich, insomuch, that the king that now is, married both his daughters unto two rich merchants. . . . Corne, cattle, milke, and butter this region yeeldeth in great abundance: but salt is verie scarce heere. . . . Here are great store of doctors, judges, priests and other learned men, that are bountifully maintained at the kings cost and charges. And hither are brought divers manuscripts or written bookes out of Barbarie, which are sold for more money than any other merchandize. . . . The inhabitants are people of a gentle and chereful disposition, and spend a great part of the night in singing and dancing through all the streets of the citie. . . .

Leo's report could not help but reinforce Timbuktu's image as the Eldorado of Africa, although European global exploration and exploitation had meanwhile shifted to the Americas, India, and Indonesia.

A hundred years after Leo's visit the great Sudanic empire of Songhai

famous Sankoré mosque was center of Islamic scholarship.



A Catalan map from 1375 shows Mansa Musa holding an enormous gold nugget as an Arab trader arrives by camel to barter with him.

lay in ruins. Following a long diplomatic quarrel and intermittent battles between Songhai and Morocco over the control of the once lucrative, but by then almost depleted, salt mines at Taghaza, the Askia dynasty, already torn apart by dynastic conflicts and civil strife, succumbed to an invading force of the sultan of Morocco in 1591. Timbuktu, which had surrendered without a fight, became the administrative capital of the colony.

Moral turpitude and vile debauchery (which historically often precedes the fall of empires) had spread before the conquest. Far from restoring public order, the conquest demolished it completely. Unable to establish a viable administration even after a guerrilla force of southern Songhai had been defeated, the sultan's suzerainty south of the Sahara could not take hold. The Tuareg and the pagan Bambara took advantage of the prevailing anarchy and mounted repeated attacks on Songhai villages and towns. A seventeenth-century Arab historian from Timbuktu wrote:

> Everything changed at that time: danger replaced security, misery followed opulence, trouble, calamity and violence succeeded tranquility. Everywhere people were destroying each other; in every place and in all directions plundering occurred, and war spared neither life nor possessions nor the welfare of the people.

These problems abroad and succession disputes at home forced the Moroccan sultan to abandon any hope of extending his dominion across the Sahara. Less than thirty years after the capture of Gao, his rule en Rival factions of the occupa army, no longer bound in duty t sultan, began to fight among th selves for control of Timbuktu an sister market towns of Djenné Gao. The troops married l women, and their descendants e up paying tribute to the Tuare their rivals, the Fulani, who then encroaching on the Middle N region, as these two peoples fo protracted wars against each o and with the Bambara for hegem over that area. The chaos that lowed Askia's rule severely stricted, but never stopped, the tr Saharan trade to the Maghreb, w in the seventeenth century increa its share in slaves and added iv which hitherto had found its n market in Egypt.

By the nineteenth century, h ever, Timbuktu and the other to of the western Sudan had lost t role as entrepôts between b

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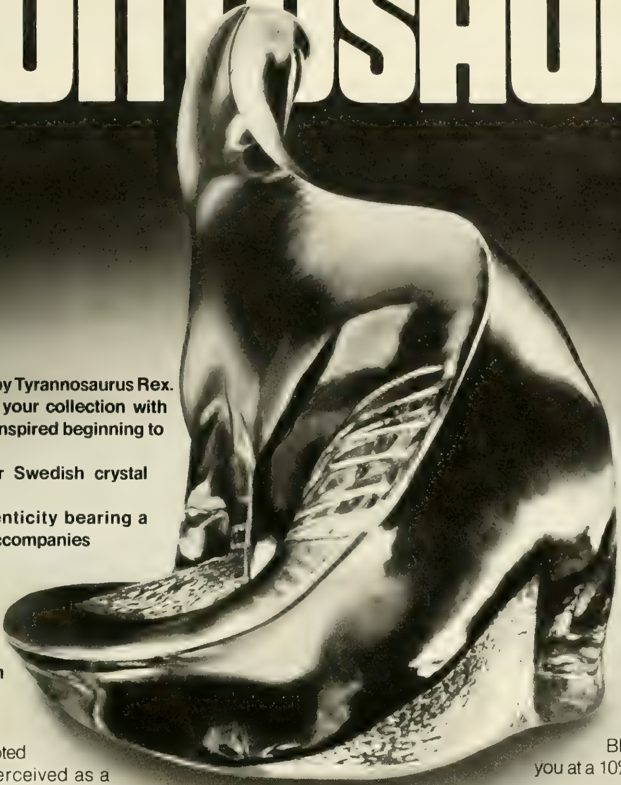

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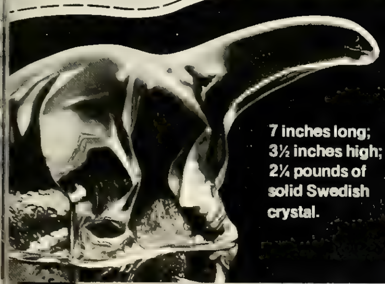

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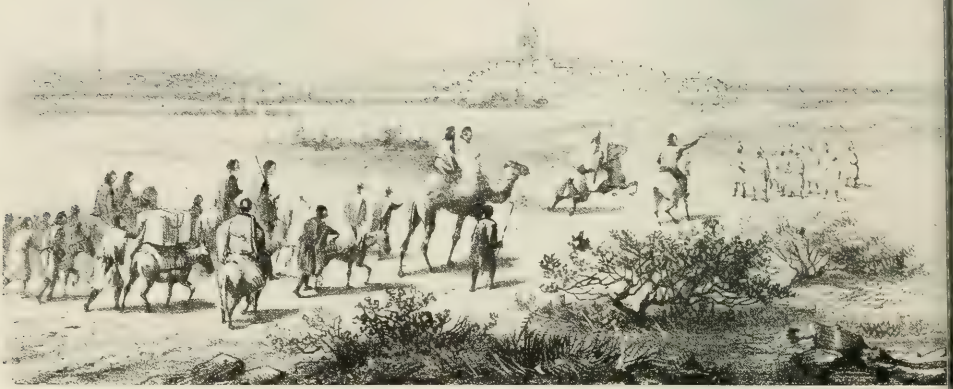
From *Travels and Discoveries in North and Central Africa,* by Heinrich Barth.


Arrival at Timbuktu

Africa and the Mediterranean coast from the Maghreb to Egypt. Since the fifteenth century, the Portuguese—and later, during the seventeenth and eighteenth centuries, Dutch, French, and English merchant houses—had established trading settlements along the Atlantic coast and diverted the flow of gold, slaves, and ivory from traditional inland routes. In the end, the ban on slavery by the European powers in the early nineteenth century virtually annihilated the trans-Saharan trade in which, by the mid-nineteenth century, slave transports made up one half the volume. As Timbuktu's export could never depend on the products of local industries, its fate was sealed with the withering of the once-steady caravan traffic.

Although as early as the 1490s King João II of Portugal had sent an ambassador to the Mali court, the geography of the Sudan and the location of Timbuktu remained a mystery outside the Muslim world until the early nineteenth century. The Portuguese had tried early to reach the gold mines, but as one contemporary historian explained in florid language,

> It seems that for our sins, or for some inscrutable judgment of God, in all the entrances of this great Ethiopia that we navigate along, He has placed a striking angel with a flaming sword of deadly fevers, who prevents us from penetrating into the interior to the springs of this garden, whence proceed these rivers of gold that flow to the sea in so many parts of our conquest.

At the end of the eighteenth century, in spite of Ibn Batuta's correct description of the Niger's easterly course, most European maps still showed the river flowing to the west because both a respected Spanish-Arab geographer and Leo Africanus had erroneously written of its westward flow. By that time the quest for Timbuktu and the direction of the Niger's course had become an obsession of some Europeans, scholars and adventurers alike.

In 1793 the Association for Promoting the Discovery of the Inland Parts of the Continent of Africa, a fancy London dinner club, sent Mungo Park, the intrepid Scottish explorer, to Africa "to ascertain the Niger's course" and to "use his utmost exertions to visit the principal towns and cities in its neighborhood, particularly Timbuctoo and Houssa." Park, coming from the Gambia, reached the Niger at Ségou,
the capital of the Bambara, in
and described its view in a passag
often quoted in the annals of Afr
discovery as Stanley's meeting
Livingston:

> Looking forwards, I saw with in
> pleasure the great object of my missi
> the long sought-for majestic Niger,
> tering to the morning sun, as broad a
> Thames at Westminster, and flo
> slowly to the eastward. I hastened t
> brink, and, having drank of the w
> lifted up my fervent thanks in pray
> the Great Ruler of all things, for ha
> thus far crowned my endeavours
> success.

"Thus far" only, for insurmou
ble difficulties forced Park's retur
England before he could once a
attempt to reach his main goal: to
the city of Timbuktu and to locate
river's estuary. During Park's sec
journey–expedition, 1805–1806,
forty-three of his European com
ions perished and he himself, tra
ing downstream by boat, lost his
in the rapids near Bussa, in tod
Nigeria, 800 miles from Timbu

Although he had reached its l
tion, Mungo Park never saw T
buktu. He was barred by hostile
tives from leaving the river at
city's port of Kabara. When

chman René Caillié, the first ern traveler to reach Timbuktu return home alive, in 1828 en- l the city disguised as an Arab, ing of its past grandeur re- ied.

> v saw this capital of the Soudan, to ı which had so long been the object y wishes. On entering this mysteri- ity, which is an object of curiosity research to the civilised nations of pe, I experienced an indescribable faction. . . . I looked around and d that the sight before me did not an- my expectations. I had formed a to- different idea of the grandeur and th of Timbuctoo. The city presented, st view, nothing but a mass of ill- ing houses, built of earth. Nothing to be seen in all directions but im- se plains of quicksand of a yellowish e colour. The sky was a pale red as s the horizon; all nature wore a dreary ct, and the most profound silence ailed; not even the warbling of a bird to be heard. Still, though I cannot ac- t for the impression, there was some- imposing in the aspect of a great raised in the midst of sands, and the ulties surmounted by its founders ot fail to excite admiration.

dmiration perhaps—but of his k through the streets he wrote: a word, everything had a dull ap- ance. I was surprised at the inac- y, and I may even say, indolence, layed in the city.''

Caillié was not the first Christian to reach Timbuktu. A year and a half before, the Scotsman Alexander Gordon Laing had entered the city, but he was slain by treacherous nomadic tribesmen on his way back through the Sahara.

Caillié's report shattered Timbuktu's splendorous image, which had intrigued Europeans long after the city had begun to decay. Yet, some people apparently had their doubts before the truth was known. In 1829, Alfred Tennyson, then a student at Trinity College, was awarded the Chancellor's medal for poetry at Cambridge University for his poem *Timbuctoo*, which contains the following prophetic lines:

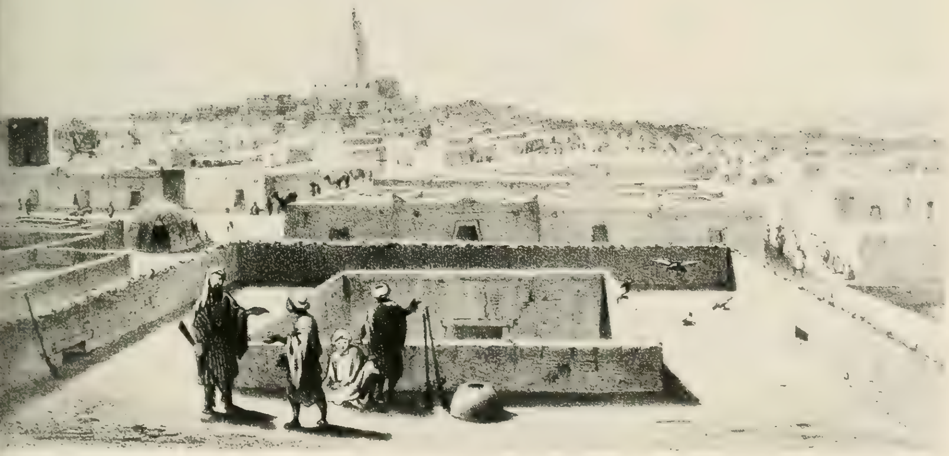
> . . . Wide Afric, doth thy sun
> Lighten, thy hills unfold a City as fair
> As those which starr'd the night o' the Elder World?
> Or is the rumour of thy Timbuctoo
> A dream as frail as those of ancient Time?
> . . . the time is well nigh come
> When I must render up this glorious home
> To keen *Discovery:* soon yon brilliant towers
> Shall darken with the waving of her wand;
> Darken, and shrink and shiver into huts,
> Black specks amid a waste of dreary sand,
> Low-built, mud-wall'd, barbarian settlement,
> How chang'd from this fair City.

Nonetheless, the legend and the lure persisted. The next European to visit Timbuktu was the German Heinrich Barth, who, in the service of the British government, reached the city from the east in 1853. That was twenty-two years after two Englishmen, Richard and John Lander, had followed the Niger from Bussa, where Park had perished, to its mouth at the Bight of Benin, thus solving one of the most tenacious riddles in the geographical exploration of the world.

Barth describes his entry into Timbuktu in the following words:

> Having then traversed the rubbish which has accumulated round the ruined clay wall of the town, and left on one side a row of dirty reed huts which encompass the whole of the place, we entered the narrow streets and lanes . . . which scarcely allowed two horses to proceed abreast.

In spite of this uninviting scene, Barth—often sick with fever—remained in and around Timbuktu for eight months, detained there by his protector, Sheikh Ahmad al-Bakai of the Kunta Arabs, a desert tribe, who at great risk to his own welfare guarded his infidel guest against the murderous designs of the Fulani.



ıbuktu, from the terrace of Heinrich Barth's house

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Barth finally escaped from this protective custody; he went down the Niger and onward to Lake Chad from where he crossed the Sahara to Tripoli on the Libyan coast. Upon his return to England he wrote his famous work, *Travels and Discoveries in North and Central Africa, Being a Journal of an Expedition Undertaken Under the Auspices of H.B.M.'s Government in the Year 1849–1855*, which probably contains, except for Ibn Batuta's work, the most distinguished travelogue ever published, although it received scant attention at that time.

In spite of Barth's perceptive description of the geography and history of Timbuktu, its mystique continued to entice travelers, scholarly explorers and eccentric adventurers alike, to go there, too. Laing, who was not the first—or the last—to die in the quest, at least had reached the city. All but one, the Austrian Oskar Lenz, who followed Barth before the French occupied the Niger plain, were forced to give up their goal en route or, in most cases, were killed in the desert before they reached the city.

In 1893/94 a French military expedition entered Timbuktu despite fierce opposition from the Tuareg who massacred two detachments in a cleverly executed ambush.

Today Timbuktu, once a metropolis of fifty thousand, is a sleepy place of about ten thousand inhabitants in the Republic of Mali. The famous mosques still stand and an occasional camel caravan still reaches the town from the Taodeni salt quarries, where production began after the loss of the Taghaza mines in the late sixteenth century. The mosques, the caravans, the tombs of some of Timbuktu's scholars, and, of course, the ethnic and cultural diversity of its population remind the visitor of the town's historic past.

Travelers who occasionally arrive by car or boat or plane need not fear the local Tuareg, who long ago discovered the benefits of the tourist trade. They offer camel rides through the dunes that ring the town and compete with other local merchants in the sale of African "antiques."

But Timbuktu's scholarly tradition finds its continuation in the archival work of the UNESCO-sponsored Centre Ahmad Baba, which collects the scattered remnants of the medieval libraries that have survived the destruction and pillage of the town's numerous conquerors. ☐

Celestial Events

by Thomas D. Nicholson

Sun and Moon The sun's movement along the ecliptic (the projection of the earth's orbital plane on the sky) takes it from the constellation Aries into Taurus in mid-May. It passes south of the Pleiades (the Seven Sisters) on May 20, north of the Hyades (and Aldebaran) about May 28, and remains in Taurus through mid-June. By the end of May, the sun will have moved to within less than 2° of its most northerly position above the earth, and the extent of daylight will be within 15 minutes of the greatest length it reaches during the year.

The moon is full in early May (on the 3rd), and it will be a morning object through mid-month (last-quarter is on the 9th, new moon on the 17th). The evening (waxing) crescent moon ought to appear by May 20, and first-quarter moon is on May 25. The moon remains a bright evening object through the end of May, becomes full again on June 1, and reaches first-quarter on June 8. Look especially for the morning crescent near Venus and Mars on May 14 and again on June 12.

Stars and Planets Saturn is the only planet on the May Star Map. Located in Cancer, between Pollux and Castor (in Gemini) and Regulus (in Leo), it appears high in the southwest at dusk and sets before midnight.

In the morning sky, Venus and Mars play out an interesting little drama. Venus, which became a morning star in early April, is rapidly becoming increasingly prominent and is easily seen in early May low in the east at dawn. Mars is also a morning star and has been since November. But it has remained dim and inconspicuous since then, dawdling along to the right of the sun. On May 13, Mars overtakes Venus and passes about one degree below it. But Venus, speeding up its easterly movement, soon keeps pace with Mars, then outpaces it, and passes it on June 3. So, for about three weeks, Venus and Mars stay close together, and Venus—easy to find because of its brightness—can help you find the dimmer Mars immediately to the south.

May 4: Expect perigee spring tides.

May 5: The Eta Aquarid shower reaches maximum. Observers may see up to 20 meteors per hour, some quite bright, in the hours after midnight, and perhaps half that number a day or so before and after.

May 11: Venus is at greatest brilliancy as a morning star.

May 13–14: Venus is in conjunction with Mars on the 13th; both are in conjunction with the moon on the 14th.

May 16: Mercury is in conjunction with the moon.

May 18: The moon is at apogee, farthest from the earth.

May 23–24: The bright object near the moon on both evenings is Saturn.

May 27: Mercury is at greatest westerly elongation, but it is not favorably placed as a morning star.

June 3: Venus and Mars are again in conjunction but begin to separate as Venus moves east more rapidly.

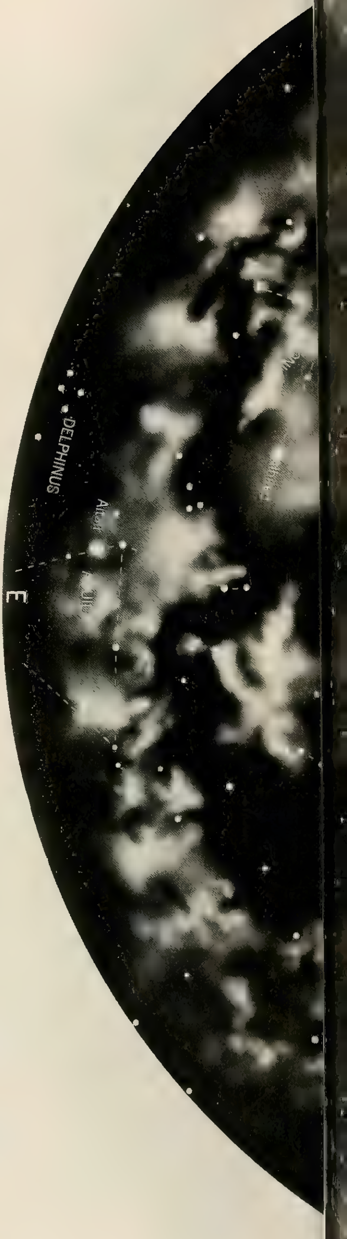
June 4: Jupiter, in conjunction with the sun, leaves the evening sky and becomes a morning star.

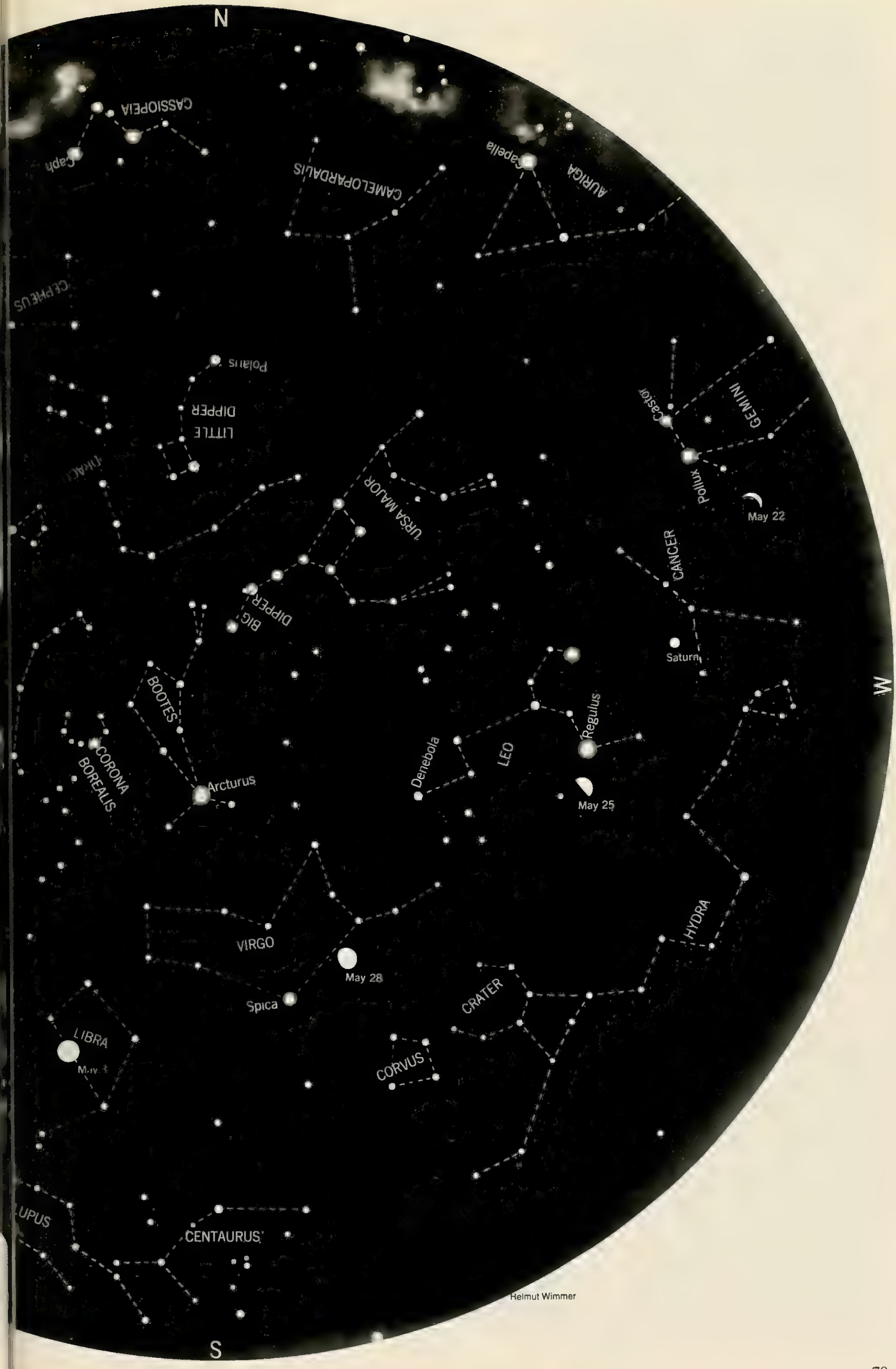
June 12: Early this morning, look at Venus, Mars, and the crescent moon. Venus is the brighter of the two starlike objects near the moon.

June 14: The moon is farthest from earth.

June 15: Venus is at its greatest distance to the right of the sun (westerly elongation), enhancing its prominence in the morning sky.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on May 1; 10:25 P.M. on May 15; 9:20 P.M. on May 31; and 8:20 P.M. on June 15; but it can be used for an hour before and after those times.

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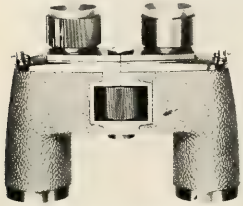

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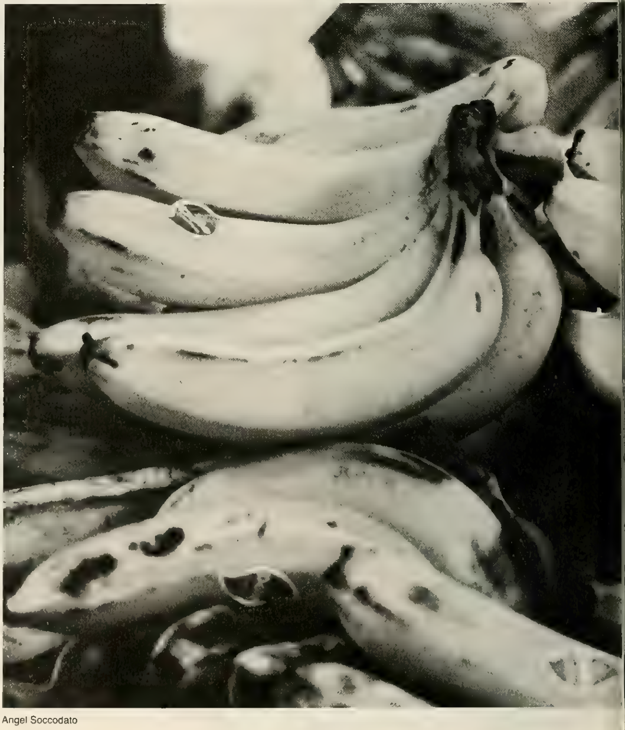
bananas.” There are many bar
jokes, most of them capitalizing
the phallic shape of the fruit. And
story about the man with the bar



Angel Soccodato

by Raymond Sokolov

s ear who apologizes for not hear- what you say because, he ex- ıs, he has a banana in his ear, is kind of humorous, cryptosexual Freud would have said made us h because it relieved the tension and fear that sex and sexually symbolic objects induce.

At any rate, bananas are intrinsically embarrassing. Peeled at the table and eaten raw, they make us think of monkeys snacking at the zoo. In my high school yearbook, the caption for a photograph of a notably simian student, in full wrestling regalia and crouched for a quick takedown, read: "Give him a banana and maybe he'll go away."

Still, most people do eat bananas. They are cheap, nonfattening (262 calories per pound), nutritious, require no cooking and almost no chewing. The problem, for etiquette conscious folk, is how to consume bananas without doing an imitation of a chimp. Amy Vanderbilt advises us that, except at picnics, we should peel the banana and then break it up "as needed into small pieces." Then it should be "conveyed to the mouth with the fingers."

I have not tried this dodge, but I did recently learn, from an exquisite Minnesotan, an even more elegant *modus banandi*. This polite Minneapolitan slices away one panel of the peel with a knife. Then, holding the remaining fruit on his plate, he slices the fruit while it is still safely ensconced in the rest of the peel. After squeezing on some lemon juice (which incidentally will prevent browning of banana flesh exposed to air), he proceeds with a fork, neatly, and with hands dry.

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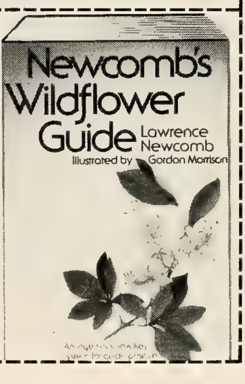

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bananas have, of course,
worked out over the thousanc
years since the first human being
downed the "elongated yellow f
(as a *New York Times* reporter
loss for a banana synonym,
wrote) in southern Asia, where
Musa genus is probably native
has been known throughout histo
times. A facetious list of ba
dishes occurs early on in Tho
Pynchon's novel *Gravity's Rain*
But even a realistic, "serious"
log of bananisms runs the ris
sounding silly: banana bread, b
bananas with brown sugar, ba
split, banana mousse, banana
cream (see recipe below), ba
cream pie, bananas and cream,
nanas and corn flakes, banana frit

There are a few imposing Fr
banana desserts, such as the elabo
tart called *bananes bourdaloue.*
can even make a banana soufflé if
remember to push the mashed
through a fine strainer; otherwise
resultant dessert will contain f
and taste like bread pudding.
there are a small number of ex
banana dishes, especially the Chi
dessert in which sliced bana
coated in hot caramelized suga
honey are dipped in ice water so
long strands of caramel solidify
stand for long life. And, if you h
the patience, you might want to
boiling down a puree of pineap
sugar, and bananas to make the M
can dessert *cajeta de piña y plát*
Diana Kennedy learned to do
from her maid, Luz, and it takes
to six hours before the puree t
into a spectacularly rich and mys
ous dark paste (see recipe below

Finally, by mentioning bana
flamed in rum, we come essenti
to the end of banana cuisine, anc
can fairly claim that most of the r
pes are American or, at least,
they have been completely nat
lized here, just like the banana its

By the early sixteenth cent
bananas had been transplanted to
hemisphere. This was part of a wo
wide proliferation that has seen
Musa clan thrive in virtually all tr
cal locations on the planet. We
think of Honduras and Costa Ric
the preeminent banana republics,
it is also the case that Queensla
Australia, is familiarly known
Bananaland, from the prevalence
the crop there. Banana beer is
characteristic drink of the Cha
who live in Tanzania around Mo
Kilimanjaro. And global produc

nanas hovers in the neighbor-
of eleven billion pounds.
nanas are a successful interna-
crop—and have been since the
nineteenth century—because
are easy to grow and easy to
Commercial bananas are
ess and reproduce through
nocarpy, without pollination.
ers separate the suckers, or ra-
, from the rootstock or they cut
e rootstock into wedges and
them. A pseudostem of concen-
ly formed leaves rises from the
d, to a height of ten to thirty
from the center of the pseudo-
sprouts the flower stalk. Near
ip of this downward-curving
are groups of sterile male flow-
surrounded by purple bracts.
buds are sold as fruit in the Far
and the inner heart of the tree is
in Ethiopia.
t most of the world consumes
the true fruit, which is the swol-
vary of the female flowers that
r farther back on the flower
These fruits grow in what we
banana fanciers would call
hes. Experts use another system
rminology. Single bananas are
ers." A cluster of eight to
e fingers is a "hand." Six to
een hands are a "stem."
takes 75 to 150 days for a stem
ture to the point where it can be
ed. Bananas ripen more effec-
and evenly if they are picked
. And certain varieties ship re-
ably well. The leading type for
years, the gros Michel, may
been relatively insipid, but it did
poil during its transit by banana
from the United Fruit docks in
luras to New York.
iquita Banana, the United Fruit
name for the gros Michel,
ed supreme until the Panama
challenged its dominion in the
following World War II. This
us disease attacks the roots of
na plants, especially the gros Mi-
and spreads upward until leaves
pse, Panama wilt destroyed
sands and thousands of acres of
Michel bananas. And it was not
the mid-1960s that United Fruit
United Brands) shifted its ban-
plantations to other, disease-re-
nt strains. These other varieties
e fruit could only travel if they
packed in corrugated boxes,
h meant a higher capital invest-
t in producing areas, but it also
d the banana industry in several
tries.

For the consumer, however, the best-tasting bananas are still the dwarf yellow and Canary Island red varieties, which appear sporadically in specialty markets. Their superior flavor is obvious.

Plantains, or green bananas, are another distinct type of the genus *Musa*, starchier and thicker skinned. They are the potato of Hispanic America, but they are just as much bananas as the soft type we are accustomed to. The confusion over names in the banana world is almost certainly the result of centuries of prescientific hybridization. Then came Linnaeus with an apparently precise system of nomenclature. Today, however, a distinguished banana specialist, N.W. Simmonds, writes that he has decided to "disregard all Latin names. . . . If ever banana taxonomy should become reasonably completely understood . . . a rational Latin nomenclature might be possible; but it is very doubtful if it would be worthwhile."

The old names do, however, retain a certain fanciful luster. "*Musa*" was once said to go back to the name of the Emperor Augustus's physician. It is also, and more convincingly, derived from the Semitic root for banana.

Musa sapientum, the Linnaean name for the common banana, reflects Pliny's notion that bananas, when discovered by Alexander the Great, were a food of the wise men of India. Indian lore also may account for the traditional plantain binomial *Musa paradisiaca,* for it was thought that the plantain was Adam's "fig" in the Garden of Eden and that it had provided the leaves that were the first human clothing.

Banana leaves are, at any rate, of bountiful dimension and are diversely useful in many parts of the world: as natural equivalents of aluminum foil in cooking, as impromptu tablecloths for eating outdoors, as umbrellas, as funnels for scooping up water, as thatching for roofs, as fodder, and for making rope.

No one is positive where "banana" itself came from, although the oldest recorded instances in English, from the late sixteenth century, indicate that the name had its roots in west Africa. None of this learned confusion about the elongated yellow fruit should deter you from your own masticatory research on its locally available cultivars and clones. Bananas always taste good with chocolate.

Banana Ice Cream

3 bananas
1 cup sugar
1½ cups heavy cream, chilled

1. Puree the bananas in a blender.
2. Heat the sugar in a saucepan with 2 tablespoons of water until the sugar dissolves.
3. Stir together the sugar and banana puree and let the mixture cool.
4. Stir in the heavy cream and chill the mixture for one hour.
5. Freeze in an ice cream freezer.

Yield: 1 quart

Cajeta de Piña y Plátano

(After a recipe in *The Cuisines of Mexico,* by Diana Kennedy)

1½ cups brown sugar
1 2-inch stick cinnamon
1 four-pound pineapple
2 pounds bananas
Juice and peel of ½ lime
2 1-inch sticks cinnamon

1. Bring 1 quart of water to a boil, add brown sugar and 2-inch stick of cinnamon, and continue boiling briskly for 20 minutes, uncovered. The liquid should reduce to approximately 2½ to 3 cups. Remove cinnamon and discard.
2. While the sugar-cinnamon mixture reduces, peel and dice all the fruit. Discard the central core of the pineapple.
3. Preheat oven to 325 degrees.
4. Mix together the reduced syrup and the fruit. Puree this mixture, coarsely, in a blender, in three batches.
5. Pour the puree into an oven-proof dish just deeper than 3 inches. Add the lime peel and juice and the 1-inch sticks of cinnamon.
6. Set the dish in the oven and cook for 5 to 6 hours. Cooking times will vary according to the depth of the dish: the deeper it is, the longer it will take to produce a rich, dark-brown, sticky mixture. Scrape the sides of the dish from time to time, more frequently toward the end, and mix the scrapings back into the *cajeta.*
7. Glaze the surface of the *cajeta* quickly under the broiler. Then let cool and serve with cream cheese.

Yield: 6 servings

Raymond Sokolov's most recent cookbook is The Saucier's Apprentice, *a guide to French sauces.*

The Cygnus A Conundrum

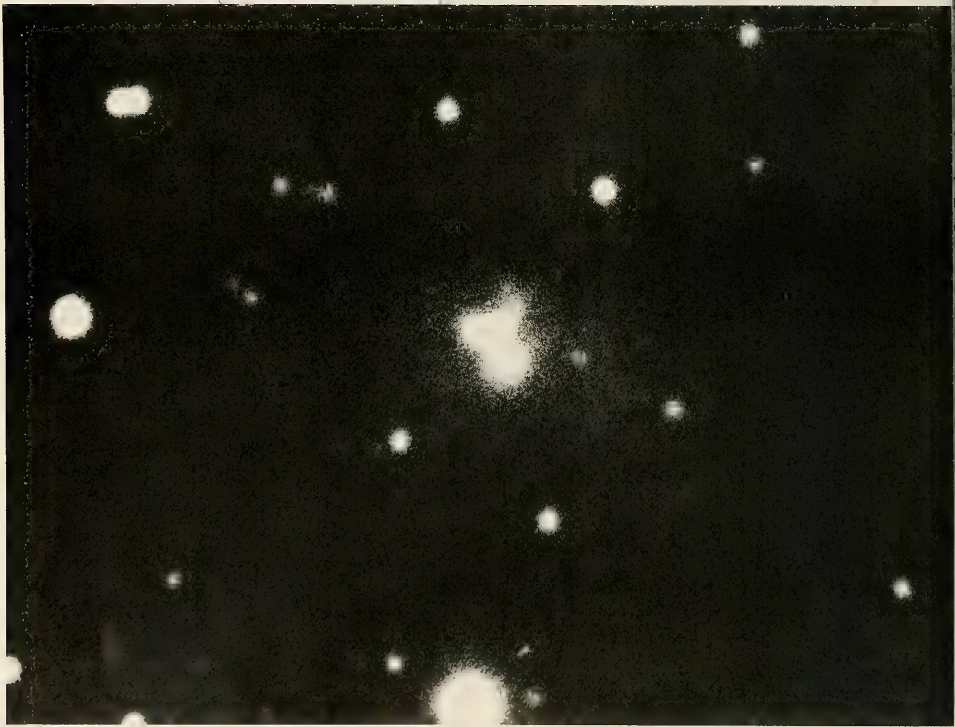
No theory yet devised fully accounts for the phenomenal amounts of radio energy released by this galaxy

In 1943, an electrical engineer in Wheaton, Illinois, whose hobby was astronomy, used a dish-shaped backyard antenna to survey celestial radio emission. Based on his observations, he prepared a contour map of a large part of the sky. The contour lines, which resembled those that indicate height above sea level on a geological survey map, showed the strength of radio waves received from different directions in space. The engineer's map revealed an intensification of the radio waves coming from the direction of the constellation Cygnus.

It was thought at the time that celestial radio emission is produced by electrically excited interstellar gas distributed throughout our Milky Way galaxy. Since Cygnus straddles the central plane of the Milky Way, where the interstellar gas is concentrated, the finding was not very surprising. The surprise came three years later, when researchers employed by the Ministry of Supply in England discovered that the Cygnus radio waves were fluctuating graph of their measurements s notable increases and decreases i strength of the received radio wa occurring only seconds apart.

These rapid changes reminde English observers of the var radio emissions that come from spots. Thus, they suggested tha fluctuating radio waves from Cy were produced by one or more cific objects, perhaps stars with turbed regions, or "starspots," ra than from a broad distribution o in space.

It was later proved that the fluc tions are not inherent in the r



Hale Observatories

by Stephen P. Maran

s but come from turbulent con-
ns in a layer of the earth's atmo-
e. They are caused by a process
gous to that responsible for the
ling of visible stars. However,
onclusion that Cygnus A, as the
source has since been named,
a highly localized, or "dis-
," object was correct. Once as-
mers knew that there were dis-
radio sources in space, the hunt
n to find their associated celestial
ts.

addition to Cygnus A, several
discrete radio sources were
found and identified with known
nomical objects, including the
Nebula, the Andromeda galaxy,
a member galaxy of the Virgo
er (a group of galaxies that is rel-
ly close to us by cosmologists'
ards). Thus, it was disconcert-
hat no conspicuous astronomical
t appeared on photographs of
egion of Cygnus A, the first
n discrete radio source, whose
l is about three million times
er than the radio emission from
Milky Way. Cygnus A is, in fact,
econd strongest radio source in
whole sky. (The strongest is Cas-
ia A, a supernova remnant like
Crab Nebula.) Finally, in 1951,
tish radio astronomer at the Ca-
ish Laboratory succeeded in
ng an exceptionally precise mea-
ment of Cygnus A's position.
sing the British radio astronomy
surements, a search was made
the 200-inch optical telescope on
mar Mountain in California for
nus A's optical counterpart. On

nus A, the object that looks
two blobs, in the center
e photograph, is one of the
powerful radio sources
liscovered.

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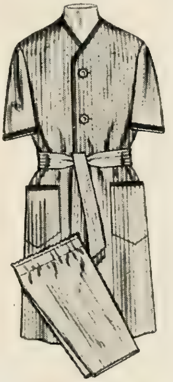

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a September evening in 1951, the region of Cygnus A was photographed from Palomar by Walter Baade, a noted extragalactic astronomer associated with the Mount Wilson and Palomar Observatories. The photographs revealed a dim galaxy of peculiar appearance in the midst of a cluster of even fainter galaxies. Other observations showed that the galaxy was about 110 million light-years from the earth. (More recent revisions in the extragalactic distance scale used by astronomers show that the true distance of Cygnus A may be as great as 1,000 million light-years.) At that distance, Cygnus A was far beyond the Virgo cluster and thus was the most remote radio source yet located. This was astounding because, as the second strongest source observed from the earth, Cygnus A might logically have been one of the closest ones. The few other galaxies then identified with radio sources produced far more energy in the form of visible light than as radio waves, but Cygnus A's radio waves were as powerful as its light.

On the Palomar photographs, the Cygnus A galaxy consisted of a rather faint, round, fuzzy image, centered on two brighter condensations. Baade proposed that this presumed galaxy was actually two colliding galaxies. The condensations were interpreted as being the respective central nuclei of the galaxies, while the fuzzy region was regarded as a superposition of their main bodies, seen in perspective. Although a large galaxy may contain hundreds of billions of stars, the stars are, on the average, very far apart. Thus if two galaxies did collide, their member stars would sift through each other with few direct hits, very much like two squads of a stadium marching band parading through each other at half time without bumping. The theory of colliding galaxies, which had been worked out even before Cygnus A was photographed, predicted that the interstellar gas of the two galaxies would be heated by the collision. And subsequent observations of Cygnus A had indeed revealed intense spectral lines caused by the emission of light by neon, oxygen, and nitrogen gases in a hot, excited state.

Later calculations, however, showed that, although the collision theory correctly predicted lines of hot gas, a collision is not sufficiently energetic to power a radio source as strong as Cygnus A. In addition, observers subsequently found 1
radio sources that resemble Cygı
but are associated with galaxies
clearly are *not* involved in collis
Argument continues as to the c
of the energy of Cygnus A, bu
tronomers no longer believe tha
galaxies are present. Instead, th
tical object may be a single large
axy with a dark central dust laye
passes across the nucleus, ma
Cygnus A seem to contain two s
rate condensations, or it may be a
axy with a double nucleus.
kinds of object are seen elsewhe
the sky.

The next finding concer
Cygnus A was made by another
ish scientist, Roger Jennison o
Jodrell Bank Experimental Sta
who was working with a new ki
radio telescope. His telescope
sisted of two large and complex
able aerials intended to gauge the
of observed radio sources. As
omers wondered if the Cygnu
radio emission came from the ga
itself or from a large surroun
"halo." By moving the ae
around the Cheshire countrysid
different days, Jennison and an a
ciate had attempted to measure
diameter of Cygnus A in each of
eral directions and, hence, deter
its shape as well as its size. W
it be circular, elliptical, or some
shape? Comparing the measurem
with the aid of simple trigonom
the answer should emerge. B
hadn't. No simple shape fitted
data.

As recounted in a book he w
Jennison, while soaking in the bat
and mulling over the problem,
lized that the observations did n
a simple shape because only *one*
ject had been considered in the ca
lations. He rose out of the tub
hour or two later, shivering but
lant in the idea that it all fitted toge
if Cygnus A were two blobs."
blobs, also called lobes, evide
produced radio waves but no li
since they are far outside the ga
in Baade's photograph, separate
about 500,000 light-years accor
to recent estimates. They are loc
at equal distances from the galaxy
a line that passes through it. Suc
object is termed a "double r
source" and is now known to
fairly common in space.

In Cygnus A and other sin
radio sources, weak radio emis
trails backward from the lobes tov
the center of the system. In s

s, the lobes are very close to
laxy, while in others they are
farther apart than those of
s A. Perhaps most significant,
re observed instances of "dou-
louble radio sources," which
wo pairs of lobes, one pair near
laxy and one pair far outside it.
uggests that whatever process
ced the blobs of Cygnus A is
to recur, creating a new set of
that, according to most
es, will travel out from the gal-
n opposite directions at high
.

e radio waves emitted by
s A are so powerful that, as one
t put it, "less than one source
million" has a comparable in-
y. Astrophysicists attempting to
nt for this energy are also con-
d with a difficulty known as the
inement problem." This term
to the puzzling fact that the
lobes are much smaller than
separation. If, as many astron-
believe, the lobes are clouds of
a, or electrified gas, then, like
rings drifting away from the
n who blows them, they should
rapidly as they recede from the
t galaxy. However, a compari-
f Cygnus A with other double
sources in various stages of de-
ment shows that the lobes do not
d as rapidly as predicted. Does
ean that something is confining
tarding the expansion of the
? Or are the lobes *not* just blobs
sma?

sic to both questions is the issue
ether the Cygnus A radio source
reated by one violent event or
ng continuously supplied with
y to power the lobes. The now-
ded colliding galaxies theory
he first example of a violent
concept to explain Cygnus A.
er such theory involves the an-
ting encounter of cosmic clouds
tter and antimatter, that is, mat-
mposed of the counterparts of
ary atomic particles but with the
site electrical charge. This idea
ropped when physicists realized
here is no way to accumulate
ient antimatter. Opinion today
s methods of continuous energy
ation.

variety of new theories have re-
y been advanced by radio-source
rchers to account for the inten-
f the Cygnus A emission. Ac-
ng to one concept, intergalactic
alling into a giant black hole at
enter of Cygnus A generates a continuous supply of energy to power the radio source. Unfortunately, the reality both of black holes and of sufficient gas in intergalactic space remains to be proved.

Another hypothesis postulates the existence of a "spinar," a "massive, rapidly rotating, magnetized object" in the galaxy. The spinar supposedly emits energy in two opposite directions, and where the beams of energy strike the intergalactic gas, they produce the radio lobes.

A third proposal is the "ram pressure theory." This concept suggests that plasma blobs shot out from the center of the galaxy are compressed by the intergalactic medium, thus accounting for the confinement of the radio lobes. However, double radio sources similar to Cygnus A are found to have comparable properties whether or not they are located in clusters of galaxies. Since the intergalactic gas should be denser in a cluster than elsewhere, this simple observation suggests that the intergalactic gas does not play a major role in the development of radio sources.

Yet another hypothesis, known as the "slingshot theory," addresses the confinement problem and combines the ideas of a violent event and a continuous energy supply for Cygnus A. In March 1976, physicists at the Massachusetts Institute of Technology and Harvard University proposed a new version of this theory. According to their reasoning, spinars were hurled out of the galaxy in opposite directions either when a parent object spun so fast that it broke apart or when an orbiting system of several spinars was disrupted. Traveling outward, each spinar generates high-energy electrons that surround it and produce the radio lobes. Although the radio emission of the electrons fades as they dissipate into space, they are constantly replaced by new electrons from the spinars. As in previously espoused theories, however, basic assumptions are made in this one that cannot yet be proved. Thus, no one knows if this latest concept is correct. But at least it avoids some objections leveled at the earlier theories and accounts in a consistent way for the main characteristics of the double radio source. That is probably the best we can hope for at this stage in the investigation of Cygnus A.

Stephen P. Maran is an astronomer at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

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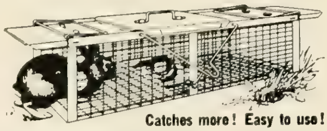
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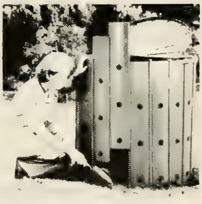

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Uninvited Guests

The Life That Lives on Man, by Michael L. A. Andrews. *Taplinger Publishing Co., $9.95; 183 pp., illus.*

For most of us, insects and other allied arthropods are a nuisance to be endured during summer excursions to the beach or mountains or around the picnic table. Diseases, such as plague and typhus, or crab louse infestations are usually relegated either to the Middle Ages, the third world, or the promiscuous. And while we marvel over the industrious bee and ant, the beautiful butterfly and moth, we are for the most part less familiar with those hematophagous arthropods that, in addition to causing wheals and welts, transmit numerous disease-causing viruses, rickettsiae, bacteria, protozoans, and metazoans.

Equally unfamiliar to most people is the microenvironment of skin where each second, on each millimeter of epidermis, a complex ecosystem—involving sweat, sebum, hair, and commensal bacteria and fungi—is continually evolving. Here then is an intriguing voyage, not unlike Gulliver's trip to the land of the Brobdingnagians, that describes the exotic microscopic fauna, flora, and other biota that surround, suckle, and invade our integument. And lest those who suffer from hypochondria or entomophobia be taken aback, it should be immediately pointed out that Michael Andrews's descriptions of our skin and the critters that crawl across it is more reminiscent of the African veld than an advertisement for psoriasis.

The mite, flea, and louse are parasites, true enough, but they are also predators. Some of the descriptions given these arthropods by Andrews raises them to the sinister majesty of the cheetah, wild dog, and hyena. Bacteria and yeasts are also perceived (especially with the use of excellent photomicrographic reproductions) as highly complex living creatures.

The book, we are told in the flap copy, is a collection of BBC programs that has been developed in greater detail for publication. This might account for a certain choppiness in presentation and duplication of material. Nevertheless, the author has assembled an eclectic assort
of personal experiences, ph
sophical asides, historical accou
remarkable photomicrographs, i
trations, sketches, and interv
into chapters that describe the sig
cance of microbes and arthropods
impinge upon people. Unenc
bered by the talmudic preciosity
doctoral candidate or the rhetor
a diagnosing physician, Andre

Gruppo natu

Bartolomeo Pinelli (Mansell Collection)

by John S. Marr

siasm for his subject is infec- He is alternately enamored by a; amazed by the exfoliation of ''scurf,'' we are told, is made millions of mote-sized particles n, which float off us each time the, dry ourselves, turn over in or put on our clothes); angry at of the more dubious medical ex- ents performed in the name of ce; and justifiably worried about the emergence of resistant bacteria that may result from the injudicious use of antibiotics. He describes these subjects accurately, documenting without footnoting and with a minimum of sensationalism.

The initial chapters introduce the physiology of skin and review historical and contemporary attitudes toward various insect parasites. These are amusing and informative, compelling one to plunge into subsequent chapters. The ecological niches of the mite, tick, flea, and bedbug, as well as that of head, body, and crab lice, are described in great detail. The microbiota of the skin and bubonic plague receive special attention in separate chapters. The final chapter summarizes the ecology of man–microbe–arthropod interdependencies and suggests that recent technological ''advances'' may in the near future, upset these balances.

There are, however, a few mistakes that are at times distracting. An entomologist friend of mine happened to read the book. He greatly enjoyed it and was enchanted to discover that, among other things, a Rothschild first discovered the vector of plague (*Xenopsylla cheopis*, Rothschild). Nevertheless, he noted some errors and, although his concerns were different from mine, they were of a somewhat similar nature. Some of Andrews's taxonomic descriptions are dated: lice are now considered to be in one order, Phthiraptera, and not separately grouped under the Anoplura and Mallophaga. Aphids are in the order Homoptera and not Heteroptera: the former are predominantly plant feeders (not bloodsuckers) while the latter often are predacious and not plant feeders. The insecticide carbamyl is a carbamate and not an organophosphate. A plate depicting the vector of plague *X. cheopis* is missing a diagnostic episternal line. So much for the exacting doctoral candidate.

I was concerned with the dated use of *Pasteurella* as the genus for the plague bacillus *Yersinia pestis*. (It was Yersin, not Pasteur, who first identified the organism.) In addition, a minor mix-up attributes the many deaths among American Indians and frontiersmen in the Bitter Root Valley of Montana and Idaho in the 1880s to a viral disease. The author confused the arbovirus causing Colorado tick fever with the rickettsia of Rocky Mountain spotted fever. This mismatch is important since it was the pioneering work of H. T. Ricketts (among others) that elucidated the epidemiology of this disease. And while most arthropod-borne diseases in the United States appear to be decreasing, the incidence of Rocky Mountain spotted fever has risen alarmingly over the past decade. Andrews mentions that there were 380 cases in 1970 and neglects to comment on the continuing upward trend, from 200-odd cases in 1959 to nearly 900 cases in 1976. He does not comment on the deceptive name given the disease—although first discovered in the Rocky Mountains, most cases occur in the Appalachians. His geography is also off when he describes a small outbreak of malaria in 1952 as having occurred in the Rocky Mountains when, in fact, it occurred in northern California.

An infestation of lice, a common occurrence in the Middle Ages, provides the opportunity for a leisurely communal delousing.

Dr. J.A Swift, Unilever

The magnification attained in this photomicrograph has transformed an innocuous dust mite into a creature of formidable appearance.

There is one additional point about which Andrews is a bit vague. In an early chapter he implies that the head louse transmits epidemic typhus. Then, in a later chapter describing mite and head louse infestations, he corrects himself, stating that the head louse (in contradistinction to the body louse) could transmit the infectious organism, but that this is a theoretical possibility and has never happened. Parents of children infested with head lice (a not uncommon problem these days) should not have to be seriously concerned about epidemic typhus in their children. Also, he laments that the only researchers addressing themselves to the head, body, and crab lice problems are in Great Britain. This I seriously doubt, attributing this bit of chauvinism to his British resources. We in the United States do not have, and should not worry about, a louse-gap problem.

The author's great enthusiasm for the subject leads me to speculate on how the original BBC program (and eventually, the book) was created. I imagine that Andrews happened across an article about a mite or, perhaps, the workings of a hair follicle. This led him to further discoveries and revelations about the skin and its microscopic and macroscopic inhabitants. Intellectual curiosity mandated a review of the literature, discussions with researchers, and a careful historical search for origins and opinions on these matters. The beginnings of the project were probably confined to the skin and its immediate occupants. The commensal bacteria and fungi were studied, followed by the intracutaneous and cutaneous parasitic mite and louse. This presumably led to other bloodsucking arthropods that, although obligate or facultative parasites, live independent of humans (and other mammals) for days, months, or years. If this is not how Andrews's project began, it at least gives a logical explanation of the book's progression. However, by discussing the flea and bedbug, insects that only upon occasion—and then but briefly—attack humans, there is an implied omission of other, similar bloodsucking arthropods, their historical importance, and the researchers who first realized their significance. What about the Diptera, for example, the mosquitoes (culex, anopheline, aedes, culiseta) and the flies (sand fly, blackfly and tsetse), as well as the other orders of Insecta that also have caused so much misery to people?

Certainly the mosquito shares an equally important part of history
the louse and the flea (plague tc
contrary notwithstanding). The
torical speculations as to the caus
malaria are fascinating reading.
ald Ross's research with the "da
wing mosquitoes" (the anophele
a hallmark in the history of medic
Even today, malaria is ranked as
leading cause of death worldwid
the World Health Organizati
Other mosquitoes and the griev
mischief they have caused sh
have been mentioned as well.
aedes, the work of Walter Reed,
the elucidation of the epidemiolog
yellow fever were omitted. Even
Patrick Manson, a British gian
tropical medicine, is not mentio
for his work in associating a mosq
with filariasis, among his many
tributions to medicine.

Other omissions cannot help bu
noted either for their historical im
tance, the absurdity of the predac
insect vectors, or the unusual na
of the diseases they cause. Theo
Smith, an American, was the
doctor to incriminate an arthropo
a source and vector of a dis
(Texas tick fever); Carlos Chaga
Brazilian, through a series of brill
observations theorized that a dis
(which now bears his name) migh
transmitted by an aggressive, bl
sucking bug. He examined the gu
the bug, found a trypanosome sim
to the trypanosome of African sl
ing sickness, searched for a sim
organism in the blood of acutel
people, and found it. This was
first time a disease was postulate
exist because of a researcher's ca
observation concerning an inse
behavior.

There are other insects,
searchers, and diseases that woul
nicely into the schema of this b
but in all fairness to the author,
inclusion of all these would
made what is now a thoroughly
joyable few hours of reading int
intimidatingly long tome. Still, t
stories should be popularized, p
erably by a writer like Andrew
would like to think that the auth
planning a sequel to tweak and e
tain us again with fact and fic
about the unseen or inapparent ju
in, on, and around us.

John S. Marr is the director and p
cipal epidemiologist of the Burea
Preventable Diseases, He
Department of New York City,
coauthor of The Black Death.

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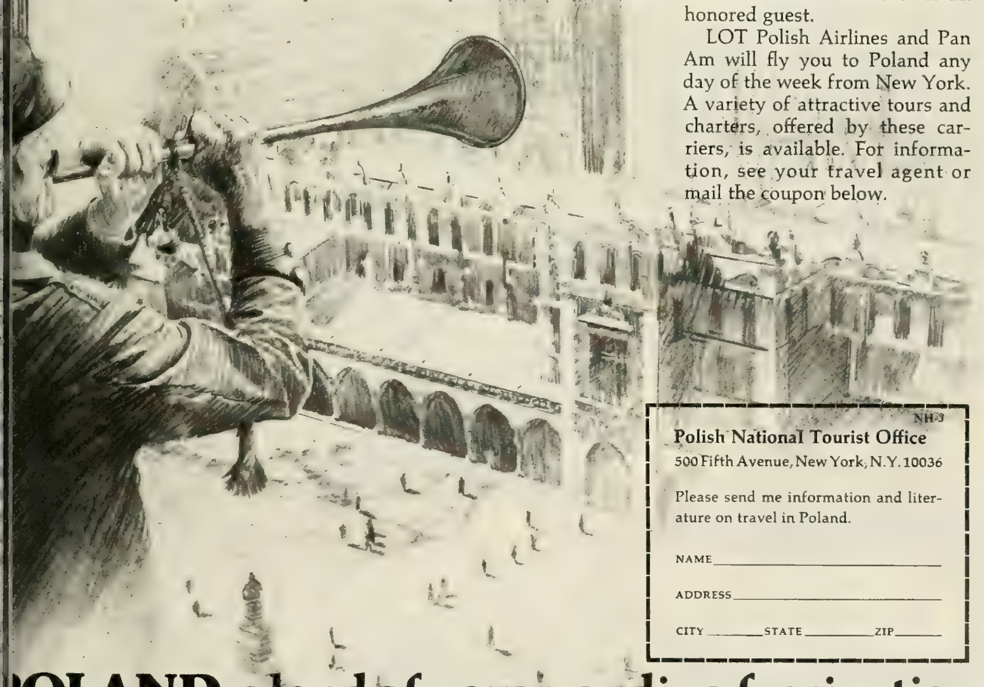

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Here are chapters on the Dogon—master mask makers, smiths and builders; on the tribes of the Pacific Northwest who still carve totem poles and masks; on cult houses in Melanesia; bronze-casting in West Africa; and rug-making among the nomads of Iran. David Attenborough explains how the artists convey their messages through their art, how their art depicts their daily lives, ceremonies and rituals.

Throughout the book are examples of tribal life and representative artworks, shown in twenty-four pages of four-color photographs and in over 200 black-and-white illustrations.

The Tribal
Eye
By DAVID
ATTENBOROUGH
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Announcements

Margaret Mead at 75, an exhibit honoring Margaret Mead, curator emeritus of ethnology at the American Museum, is on display in the Museum's temporary exhibit hall on the second floor, between the African Mammal Hall and the Man in Africa Hall. The display features photographs of Mead as a child, as a student, and as an anthropologist in the field and in the Museum. Quotations from Mead, which explain her attitude toward her work and the study of anthropology, accompany many of the photographs.

The American Museum of Natural History is sponsoring a two-week **Voyage of Discovery: The Island World of Britain** from June 17 to July 3 aboard the luxury motor yacht *Argonaut.* Participants, limited to 150, will visit the unspoiled Scilly Islands, the Inner and Outer Hebrides, and the Orkney and Shetland islands, as well as mainland ports. They have an opportunity to study the ture, history, flora and fauna of t ancient islands. Prominent scien will lecture on a variety of ant pological and natural history sub during the cruise. Further info tion and application forms may be tained from Ellen Stancs, Amer Museum of Natural History, Ce Park West at 79th Street, New Y N.Y. 10024.

As part of its four-day-long cen nial celebration, **The New York croscopical Society** will hold open house on May 14 from 1 A.M. to 3:30 P.M. in room 419 o Museum. During the event, ent "Wonders of the Micro-Wo members of the society will dis their microscopes, many of them tique. Visitors will be able to exan microscopes firsthand and to slides of colorful crystals and fib as well as examples of living pr zoans and other forms of microsc life. The open house will be an ex lent opportunity to introduce chil to a rarely seen world. The event also include a display of photomi graphs and photomacrographs t by society members. Although connected with the Museum, the croscopical Society meets regul in room 419 to discuss the latest plications in the field of microsc

An exhibit entitled **Maps–T Science and Art** will open on 11 in Gallery 77 on the first floo the Museum. The display will exp scale and projection of maps, they are made, and how scient use them in various aspects of search. Featured in the exhibit wi many maps of the New York gion—some of great histor value—on loan from the Amer Geographical Society.

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Additional Reading

Andean Agriculture (p. 32)

Kuyo Chico: Applied Anthropology in an Indian Community, by Oscar Nuñez del Prado and William F. Whyte (Chicago: University of Chicago Press, 1973, $9.50), and Stephen B. Brush's *Mountain, Field, and Family* (Philadelphia: University of Pennsylvania Press, to be published in 1977) provide complementary cultural perspectives on the subsistence strategies of people coping with the mountain ecology of western South America. Ciro Alegría, one of Latin America's foremost novelists, in his epic masterpiece *Broad and Alien Is the World* (trans. by Harriet de Onis, New York: Farrar and Rinehart, 1941), depicts from firsthand knowledge the struggles of Indians to survive in the Peruvian highlands. Craig Morris's ''Master Design of the Inca'' (*Natural History,* December 1976, pp. 58–66), describes the Inca road system as it affected the land-use patterns and economy of the Peruvian highlands. ''Man's Use of an Andean Ecosystem,'' by Stephen B. Brush (*Human Ecology,* 1976, vol. 4, pp. 147–65) is his professional report of the research described in his article for *Natural History.* Other classic studies of land-use patterns can be found in H. Milstead's ''Distribution of Crops in Peru'' (*Economic Geography,* 1928, vol. 4, pp. 88–106) and C.O. Sauer's ''Cultivated Plants of South and Central America'' (pp. 487–543), in Volume 6 of the *Handbook of South American Indians,* edited by Julian Steward (Washington: Bureau of American Ethnology, 1950). Potatoes, the central crop of Peruvian Indians, are discussed in D. Ugent's ''The Potato'' (*Science,* 1970, vol. 170, pp. 1161–66) and in Redcliffe N. Salaman's recently reissued, absorbing 1940s account *The History and Social Influence of the Potato* (Cambridge: Cambridge University Press, 1970).

Mussel Attachment (p. 42)

J.E. Morton's *Molluscs: An Introduction to Their Form and Function* (4th ed. Atlantic Highlands: Humanities Press, 1967, $3.75) is an intelligently written overview of this animal group. *Marine Mussels: Their Ecology and Physiology,* edited by B.L. Bayne (Cambridge: Cambridge University Press, 1976), although more technical, is also recommended. Irving A. Field's ''Biology and Economic Value of the Sea Mussel *Mytilus edulis*'' (*Bulletin of the United States Bureau of Fisheries,* 1922, vol. 38, pp. 127–259) is a classic monograph presenting an account of the ecology, anatomy, and related life history of one species of bivalve. Details of Arnold Tamarin's studies of this mussel group can be found in his technical papers in the *Journal of Morphology:* ''An Ultrastructural Study of Byssus Stem Formation in *Mytilus californianus*'' (1975, vol. 145, pp. 151–78) and ''The Structure and Formation of the Byssus Attachment Plaque in *Mytilis*'' (1976, vol. 149, pp. 199–222). Also see the important paper he wrote with biochemist Patricia Keller: ''An Ultrastructural Study of the Byssal Thread Forming System in *Mytilis*'' (*Journal of Ultrastructure Research,* 1972, vol. 40, pp. 401–16). Werner Nachtigall's *Biological Mechanisms of Attachment: The Comparative Morphology and Bioengineering of Organs for Linkage, Suction, and Adhesion* (trans. by M.A. Biederman-Thorson, New York: Springer-Verlag, 1974) offers a perspective on the methods used to solve the problem of attachment throughout the animal kingdom.

Sod Houses (p. 48)

Through insightful descriptions of the impact of climate and geography on the settlers of the Great Plains, two of Everett Dick's books—*The Sod-House Frontier: 1854-1890* (Lincoln: Johnsen Publishing Company, 1954, $8.95) and *Conquering the Great American Desert* (Lincoln: Nebraska State Historical Society, 1975, $10.95)—provide a rich sociohistorical context for understanding the rise of sod house construction. In *House Form and Culture* (Englewood Cliffs: Prentice-Hall, 1969, $2.95) architectural historian Amos Rapoport discusses theories of the interaction of geography, social structure, and traditional architecture. Illustrated with a fine series of line drawings, Rapoport's work deals mainly with primitive folk cultures and how their housing relates to their environment. Roger L. Welsch's own studies of the folklore of plains architecture can be found in *Sod Walls* (Broken Bow, Nebraska: Purcells, 1968, $10). Based on his analyses of more than 1,000 photographs of sod structures, Welsch's book describes variations in form and construction and documents the evolution of this folk
tecture by drawing on oral histories
from those who built and lived i
houses. His article ''Sod Constructi
the Plains'' (*Pioneer America,* 196
1, pp. 13–17) has been reprinted
pamphlet; write the Nebraska Stat
torical Society, Lincoln, NB 6850
ask for ''The Nebraska Soddie.'' W
recommends a fine spring day, w
promise of good weather to follo
counter the depressing effects of re
Ole E. Rölvaag's *Giants in the*
(New York: Harper & Row, 1
$1.25), a novel that captures and po
in vivid prose the impact of the
Plains on the minds of Scandinavia
migrant farmers.

Animal Trafficking (p. 54)

F. Wayne King's ''Adventures
Skin Trade'' (*Natural History,*
1971, pp. 8–16) and Bernard Nie
mann's ''The Nicaraguan Skin Co
tion'' (*Natural History,* January
pp. 28–30) offer complementary vie
the attempt to control the internat
trade in animals and animal prod
Jaclyn H. Wolfheim's ''The Perils o
mates'' (*Natural History,* October 1
pp. 90–99) details the impact of n
activities on the dwindling habitats
numbers of some primates. Two boo
the world-renowned Swiss zook
Heini Hediger—*Wild Animals in Ca*
ity: An Outline of the Biology of Zoo
cal Gardens (1950) and *The Psycho*
and Behaviour of Animals in Zoos
Circuses (1955)—have been trans
by Geoffrey Sircom and reprinted in
pensive paperback editions (New Y
Dover Publications, 1964 and 1
Hediger's books contain much data
many observations not found elsew
as well as offering a zookeeper's pers
tive on acquiring, keeping, and exh
ing wild animals. Gerald Carson's
Beasts, and Gods: A History of Cr
and Kindness to Animals (New Y
Charles Scribner's Sons, 1972, $2
traces the relationships and attitude
man toward the ''lower'' anir
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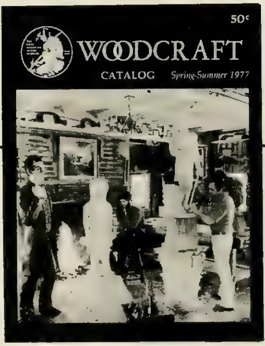

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Plants'' (*Federal Register,* Octo
1976, vol. 41, no. 208, pp. 47,1
which lists species and common
population estimates, portions c
range where pressures are seve
other useful information. This
gered Species List can also be o
from the Office of Endangered S
U.S. Department of the Interior,
Street, Washington, D.C.

Timbuktu (p. 68)

J.O. Hunwick's ''Religion and
the Songhay Empire, 1464–1591
296–315) in *Islam in Tropical*
edited by I.M. Lewis (New York:
University Press, 1966), is a wel
mented study of Islamic traditio
danic religion, and the political
zation of the Songhai empire in t
before the Moroccan invasion of
gion of Timbuktu. Nehemia Levtz
eminent scholar of African and
history, has used Arabic primary
to trace the relationship of trade a
ernmental structure from the eigh
sixteenth centuries in his book,
Ghana and Mali (New York: Ba
Noble Books, 1973, $7.50). Met
historical scholarship can also be
in Edward W. Bovill's classic
work, *The Golden Trade of the*
(2nd ed. New York: Oxford Un
Press, 1970, $2.95), a most reada
count of the rise and fall of the S
empire. Bovill has also written
nating account of the search for the
of the area's most important wat
The Niger Explored (New York:
University Press, 1968). Horace
The Primitive City of Timbuktoo (r
New York: Anchor Press/Dou
1965, $1.75), based on his 1940
graphic field investigation of the
organization, economics, and reli
Timbuktu, stands as a model
pological study of a city. Brian Ga
The Quest for Timbuctoo (Londo
sell, 1968) is a well-researched
tractive history of the search for A
''mystery city.'' The book's mater
drawn from the original autobiogr
accounts and travelogues of Tim
earliest explorers. Many of these
accounts, which Professor Koch
in his piece in these pages, hav
reprinted and, as such, are avail
many libraries. These include Le
canus's *The History and Descrip*
Africa and of the Notable Things
Contained, edited by Robert Bro
translated by John Pory (New Yor
Franklin, 1963); Mungo Park's *Th*
nal of a Mission to the Interior of
(Saint Clair Shores, Minnesota:
arly Press, 1973); Heinrich Barth's
els and Discoveries in North and
Africa and René Caillié's *T*
Through Africa to Timbuctoo (B
ton, Oregon: International Sc
Book Services, 1965 and 1968).
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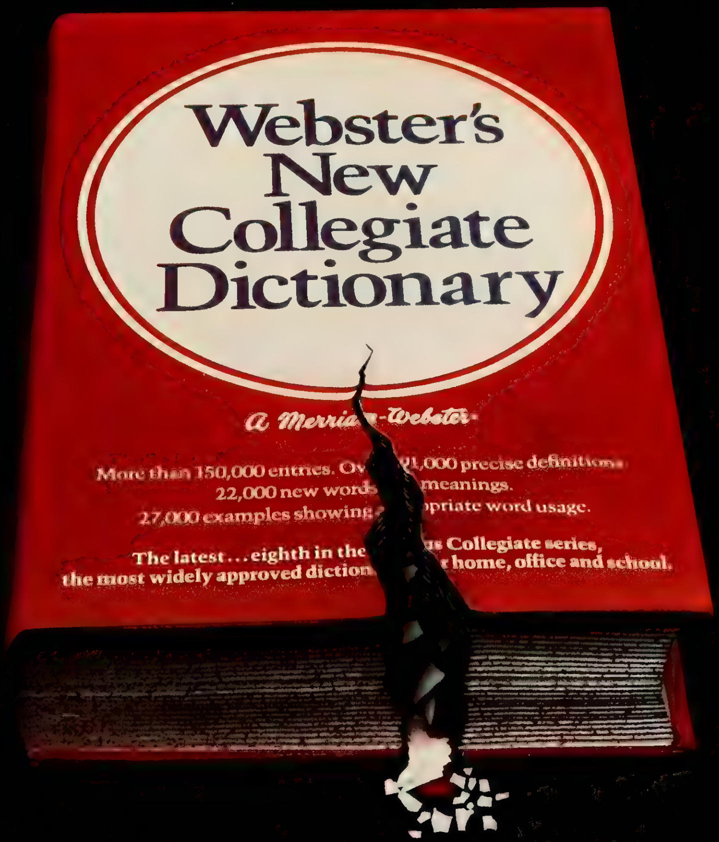
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Incorporating Nature Magazine
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June-July 1977

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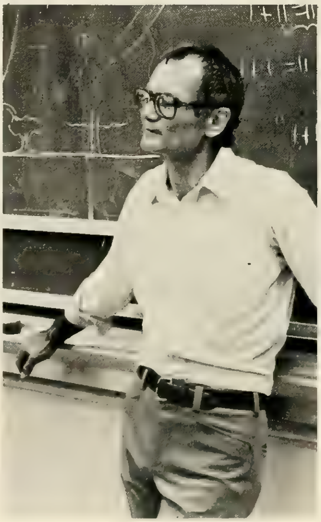
Authors

No stranger to these pages, atmospheric physicist **Robert Jastrow** last appeared in the March 1977 *Natural History* ("Report from Mars"). A commuter between New York and New Hampshire, he is an adjunct professor of geological science at Columbia University and of earth science at Dartmouth College. For the past fifteen years, he has also been the director of the Goddard Institute for Space Studies in New York City. The author of several books, with a new one currently in progress, Jastrow appeared in a series of television programs on space science that ran in 1964 and 1971 on CBS-TV. He has been a recipient of the Columbia University Medal for Excellence (1962), the Arthur S. Flemming Award (1964), and the NASA Medal for Exceptional Scientific Achievement (1968).



Unknown to each other until a year ago, both **Edwin S. Dethlefsen** and **Kenneth Jensen** had been independently studying gravestones for a number of years: Dethlefsen in New England ("Death's Head, Cherub, Urn and Willow," *Natural History,* March 1967) and Jensen in Alabama. They met last July at a seminar on American civilization and discovered their mutual interest. Dethlefsen, who teaches anthropology at Franklin Pierce College in New Hampshire, is continuing his research on New England cemeteries, using them as models for cultural change. He is also excavating several Spanish and English shipwrecks off Bermuda. Jensen, who teaches anthropology at Oregon College of Education, has shifted his attention from southern to western cemeteries.

Professor of biology at Am College, **Lincoln P. Brower** been studying the behavioral ec of monarch butterflies for r years, with support from the Nat Science Foundation. Part of his rent research involves the ecolo chemistry of Danaidae butterflie the milkweed plants on which are reared. Brower is also inter in riverine ecology and federal control policy. He writes tha wants to "provide an intelle Achilles' heel to divert the Army Corps of Engineers, the Soil Conservation Service, and Bureau of Land Reclamation ruining rivers with dams and c nelization." A professional scie filmmaker, Brower's movie or monarch butterfly will be rele this month by Harper & Row.

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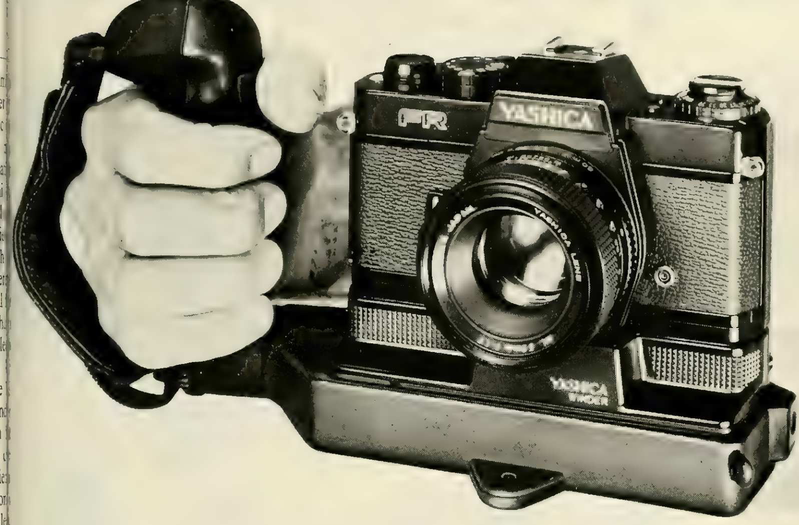

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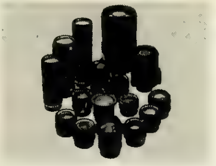

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Volkswagens may look like small cars, but only on the outside.

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A VW Rabbit, for example, has (incredibly!) more space for people than 19 other cars in its class, including Monza, Mustang, Pinto, Sunbird, Datsun F-10, and Toyota Celica.

The Rabbit also has (shockingly!) more trunk space than 34 other cars, including Cadillac Seville, Thunderbird, Camaro, Monza, Nova, Comet, Starfire, Firebird, Skylark and Ventura.

These are official U.S. Governmen tistics, by the way, published in the of Environmental Protection Agency 1977 Mileage Guide.

The Rabbit also goes like a bat out of know-where. From 0 to 50 in 7.7 secon sports car performance.

Moving along smartly to our Dasher hope you'll be floored to learn that the Dasher Wagon, according to the same guide, has more trunk space than wagon in its class made by any other m facturer. Meaning General Motors, Chrysler, Datsun, Toyota.

Rabbit

nergy crisis
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d if
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e, Dasher
comes in a beautifully appointed
r Hatchback and 4-door Sedan. Yet
Dashers have way more passenger
and trunk room than *any* Japanese
their class and more than most Amer-
ars in their class.

ally, Scirocco. The VW
co is a true sports
at can bring home
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ies on Sundays.
rocco is just some-
else, beating every-
in its class (and a
other classes). Yet
more trunk space
any—repeat—*any* car in its class made by any—repeat *any*—manufacturer.

All the new Volkswagens were made for the times that are on us now. All three get 24 MPG in the city, Rabbit and Scirocco get 37 MPG on the highway, Dasher gets 36. (EPA estimates with standard transmission. Actual mileage depends on how and where you drive, optional equipment, and the car's condition.)

Yet even with all this economy, there is nothing quite like them for their combination of handling, performance, reliability, safety, space and just plain wisdom of design.

You're going to appreciate them. Better still, you're going to love them.

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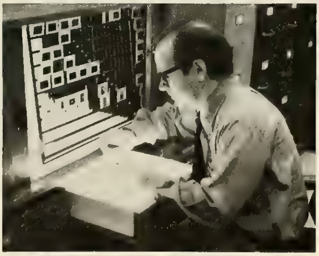
Leslie D. Garrick is a research fellow with the Center for Field Biology and Conservation of the New York Zoological Society. His present research is on the ecology and behavior of the American crocodile in the Greater Antilles. Garrick has studied alligators and crocodiles in Florida, Jamaica, Panama, and the Dominican Republic. A strong interest in crocodile conservation has led him to serve as an observer for the American Crocodile Recovery Team in Florida.

Coauthor of "The Alligator Revealed," **Jeffrey W. Lang** is a Ph.D. candidate in the Department of Ecology and Behavioral Biology at the University of Minnesota. He is currently finishing a research report on the thermal behavior and physiology of alligators and another on the social behavior of the American crocodile. Both reports are based on work done in south-central Florida. His next project will be a comparative study of several tropical crocodilian species. A trip to the Northern Territory of Australia to investigate the estuarine crocodile is in the offing.

Bruce E. Bechtol and **Jerry R. Williams** began their study of litter on a California beach in 1969 with a community clean-up project. A few years later the authors used the beach as a classroom for courses in environmental sciences at California State University, Chico, where they both teach in the Department of Geography. Bechtol and Williams are looking into the nature of litter and ways of dealing with solid waste. One research method they frequently employ is to survey the amount and kind of litter in and around roadside trash cans. Their principal effort, however, lies in pointing out the damage such pollution does to both the environment and human beings.

While working toward a doctorate in meteorology at the University of Arizona in the 1960s, **Richard E. Orville** witnessed many severe thunderstorms and became interested in the dynamics of lightning. A serious amateur photographer, he has since then pursued his interest, camera in hand, in Switzerland and, most recently, as a member of an investigative team based at the Kennedy Space Center in Florida. An article by Orville entitled "Lightning Through a Lens," illustrated with his photographs, was published in the January 1966 issue of *Natural History.* Orville is currently a professor in the Department of Atmospheric Science at the State University of New York at Albany. He and his family like to go on camping trips in New England and know exactly what to do when caught in a thunderstorm—they crouch, but don't lie, on the ground, with their feet close together.



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ORK, Amsterdam: Custom Gun-
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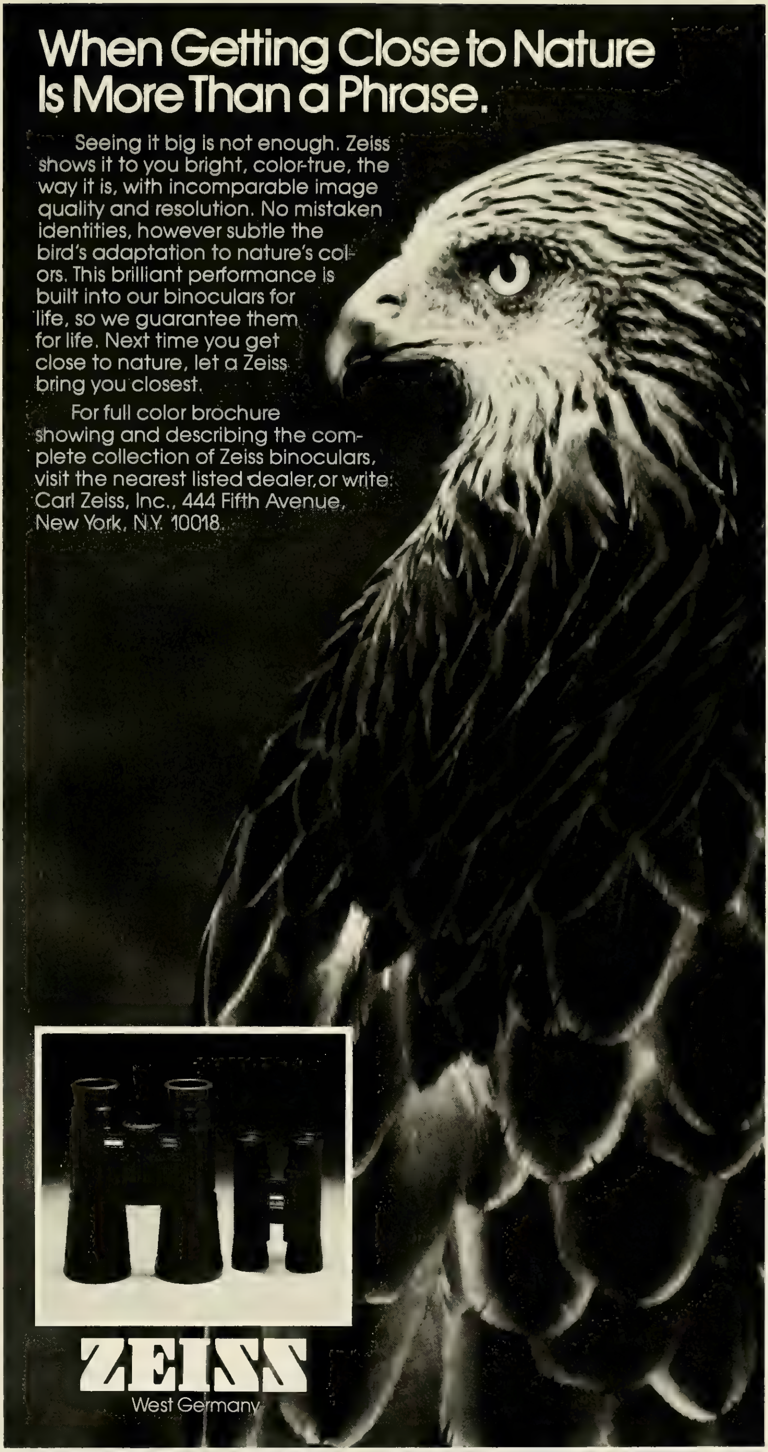

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ZEISS
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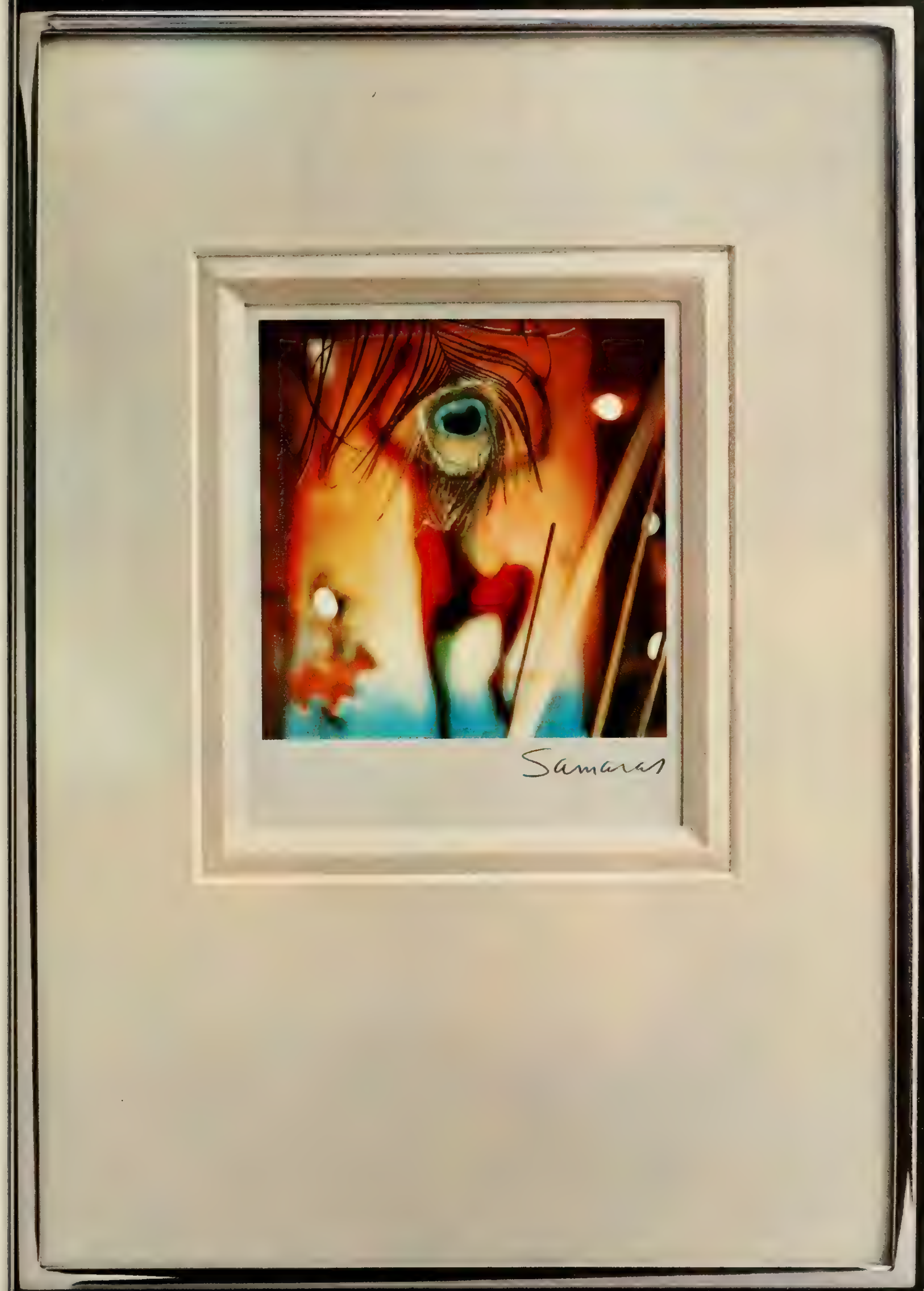
This Polaroid SX-70 photograph is part of the collection of the Museum of Modern Art.

The work is by Lucas Samaras, one of America's foremost artists. It is part of one of the world's most important collections. It was produced using the finest instant photographic system in the world, the Polaroid® SX-70® Land camera. That same camera is owned by millions. A camera of extraordinary quality and versatility capable of exposures from 10.4 inches to infinity. A film of remarkable clarity and definition of detail whose color is among the most stable and fade-resistant in existence. Samaras' work of art from the SX-70, a work of art in itself.


Samaras

OPERATION

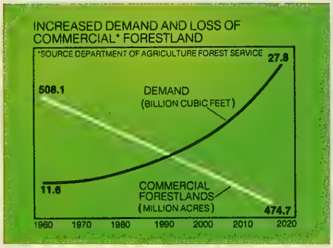
A report on how the forest industry is working to get twice as much wood from America's commercial forests. Year after year. Forever.

Wood is one of the world's most valuable resources.

It's America's busiest building material. It's also the basic ingredient in pulp, packaging and a thousand other products—right down to the paper this ad is printed on.

More Wood From Less Land.

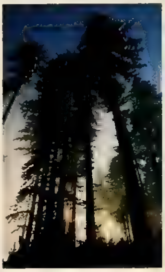
But while world demand for wood is *increasing*, the amount of land available for commercial forests* is *shrinking*. Some of it has been set aside for parks and wilderness areas. Much of it has been turned into farms, freeways and new developments.



The chart above shows that U.S. consumption of all wood and paper products will double in less than 50 years. Thus the reason behind Operation Double Tree—the forest industry's name for intensive forest management that can double the amount of wood grown on a given piece of land. And do it in such a way that the forest remains a valuable part of the ecosystem.

Double Tree is ambitious and is already working.

All across the U.S., forest product companies are working to double forest yield. In Oregon and Washington, forest product companies are predicting triple growth with genetically superior trees planted in prime forestlands.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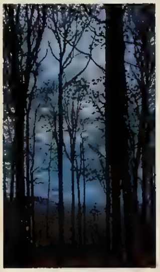
South


Great Lakes

New England

Through thinning efforts alone, some companies in the Great Lakes States have increased diameters of remaining trees enough to double wood volume per acre over a 35-year period.

Double Tree isn't limited to larg
trial tree farms. Individual w
owners from Maine to Georgia a
ting idle lands to work, creating
belts that offer the twin payoff
increased harvest *and* eternal f

That may sound like a parad
eating a cake and having it, too.
like oil or coal, wood is one nat
source that is *renewable*. And r
forestry has found ways to make
Nature more productive.

Today's intensive forest mana
is rooted in nature's own ecological
begins with the harvest. Slower g
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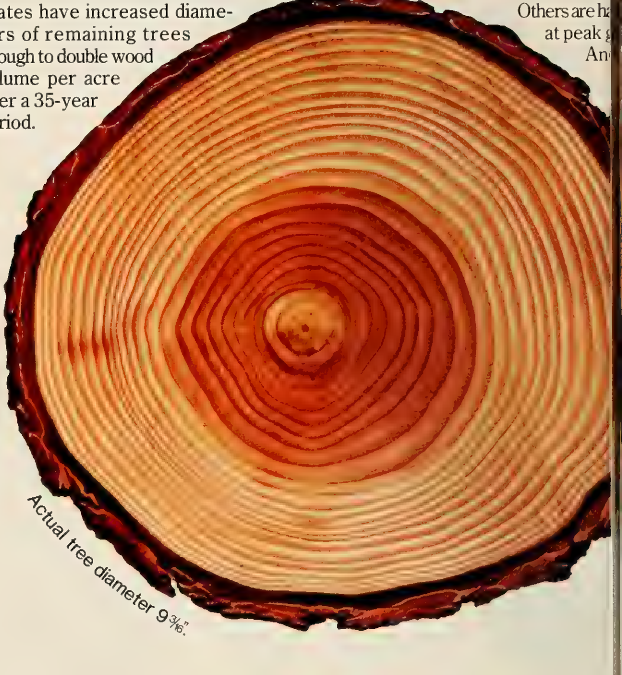

The two Douglas firs to the right grew in the forests of the Cascade Mountains of Washington State. Both were harvested when they were 25 years old. The difference is, the larger one grew in an Operation Double Tree area, while the smaller one did not.

Commercial forest is described as that portion of the total forest which is capable of, and available for, growing trees for harvest. Parks, wilderness and primitive areas are not included.

OUBLE TREE

is made to use every last part of : tops, limbs and bark.

w Forest.

t the real key is in the *new* for- new trees.

some areas, foresters plant new s by machine, or by hand. Heli- are also used to re-seed. When seedlings go in, the forest often five-year head start over natural ation in the same area.

ny of them are of genetically su- stock, the result of years of se- "breeding." Seedlings by the hun- f millions are grown in special s. They're healthier, faster grow- t mature faster and can be har- sooner.

me forestlands, such in the Northeast e States, are Aother

Wood is America's busiest building material.

Nature because natural regeneration does a better job.

Soil studies determine prime growing areas. When necessary, nutrients are added. And the young trees are protected from destructive insects, fires and natural enemies.

The result is a better quality forest, one that can be at least twice as productive.

Who Owns The American Forests?

Significantly, the principles of Operation Double Tree are being used on only a small portion of America's forestland. And good as Double Tree is, it might not be enough. Too much of the American forest is still under-utilized and under-productive.

Overall, industrial forestlands are working the hardest. Industry owns only 13 percent of the commercial forestland, but it provides almost 30 percent of the total harvest. Some 4 million private individuals own 60 percent. Government owns about 27 percent.

All of which means we must join to make the most productive use of our remaining commercial forestland. Industry has invested millions to make the concept a reality. But money isn't enough. Leaders and landowners alike must understand the problem. And, more important, the solution.

For more information, write for our free booklet "Managing the Great American Forest,"
American Forest Institute,
P.O. Box 873,
Springfield,
VA 22150.

Actual tree diameter 11⅛"

Trees. The renewable resource.

Post-Human Intelligence

by Robert Jastrow

By the twenty-second century, biological organisms may not have the highest intelligence on earth

Some twelve to fifteen million years ago, a few venturesome primates emerged from the safety of their forest dwellings and moved onto the savanna. At that time the line of human descent split off from the main stock of the apes. A record of the migration of this splinter group remains in the form of scattered jawbones whose dentition suggests a grassland diet and a life in the open. For many millions of years thereafter, the record of human origins is nearly blank. The trail reappears in rocks about five million years old that contain the fossilized remains of a small animal—in size and appearance like a pygmy chimpanzee, yet with a curiously humanlike posture. This was *Australopithecus,* the ape-man.

Bones found in the campsites of *Australopithecus* in Africa reveal that the primate had developed a strong taste for meat. It ran with the other carnivores of its time and was a competent hunter, holding its own against the lion and the giant hyena. Yet it was a puny creature, slight in build, weighing perhaps seventy pounds, and without slashing canines, claws, or other weapons. But its physical weaknesses were balanced by the strength of its intellect.

The brain of *Australopithecus* was not of impressive size, being about as big as a fist and only moderately larger than the brain of the chimpanzee. But in proportion to the weight of the body, the brain of *Australopithecus* was twice as large as the brain of the ape. Every animal uses a part of its brain as a telephone exchange, receiving signals from the body and sending out messages in return. *Australopithecus,* with a body considerably smaller than the ape's, required fewer brain cells for that purpose and had more gray matter available for the storage of past experience and the contemplation of future actions.

Australopithecus achieved this brain size four or five million years ago, about ten million years after its ancestors had moved to the savanna. The primate seems to have changed little thereafter, either in brain or body. Like many prior forms of life, the ape-man had reached an evolutionary dead end; it had become a living fossil. Between one and two million years ago, it became extinct.

Well before *Australopithecus* vanished, another intelligent animal appeared in Africa. This creature was a relative of *Australopithecus,* with similar bodily traits, but its brain was considerably larger. The new animal was *Homo*—the first man. *Australopithecus* and *Homo* lived on the same continent for several million years. Throughout that long interval, while the intelligence of *Australopithecus* remained unchanged, the brain of *Homo* continued to grow. The fossil record has not revealed why one cousin became more intelligent than the other; we only know that a million years ago, when *Australopithecus* disappeared, *Homo*'s brain had become twice as large as that of the ape-man.

Homo was a bright animal one million years ago, and a determined one. Its technology for making stone tools represented a high level of organization and planning. Mary Leakey, widow of British archeologist-anthropologist Louis Leakey, has found evidence that *Homo* sco
the neighborhood for miles arou
a search for the particularly
kinds of stone needed for its tool
ing activity. When such stones
found, the animal brought them h
to its workshop. The implicati
that *Homo* had developed an
dustry: it thought out its needs i
vance; gathered its materials; wo
on them from day to day; and
it had fashioned the tools, saved
for repeated use. In intellect, *H*
was superior to all other anima
its day; yet nature's work on its
was far from complete. *Homo* w
nearly finished creature from the
down, but its skull held a brain
half the size of the brain of mo
man.

Starting about one million y
ago, the human brain began to
at a considerably faster pace. I
panded at first at the rate of one c
inch—a heaping tablespoonful
additional gray matter every 100
years. Then the growth rate dou
doubled again, and finally, it dou
once more. Between 300,000
500,000 years ago, the rate of gr
hit its peak. At that time the hu
brain was expanding at the phen
nal rate of ten cubic inches e
100,000 years.

No other organ in the history o
is known to have grown so fast.
factors generated this explo
growth? The toolmaking industr
early man is part of the answer.
possession of a good brain ena
Homo to make tools in the first pl
but the use of tools became, in
a driving force toward the evol
of an even better brain. The evol
of speech was also import
Through the spoken word, a ne
vention in toolmaking could, fo
ample, be communicated rapid
others. In this way the innovative
of the individual enhanced the

© 1977 by Robert Jastrow. Adapted in part from his forthcoming book, *Until the Sun Dies,* to be published by W.W. Norton & Co., Inc.

l prospects of the group, and the
tive strength of one became the
ngth of all. Spurred on by these
umstances, the centers of the
n devoted to speech grew in size
complexity, and in the course of
y generations the whole brain
v with them. As in the technology
toolmaking, reciprocal forces
e into play in which speech stim-
ed better brains and better brains
roved the art of speech and the
e of brain growth spiraled up-
d.

change in climate that set in
ut two million years ago may also
e played a role. About that time,
world began its descent into a
t Ice Age, the first to afflict the
et in hundreds of millions of
s. Sheets of ice moved steadily
hward, and by the time human-
l had established itself in temper-
latitudes, ice covered large parts
urope and Asia. European sum-
s then were nearly as cold as
ters today. In that difficult period,
traits of resourcefulness and inge-
y must have been of premium
ue. The individual who first
ght of stripping the pelt from a
ghtered beast and wrapping it
nd his or her shivering limbs was
Einstein of the day. Only by such
ntive flights of the imagination
ld the naked animal survive the
rs of a harsh climate. These cir-
stances must have further ex-
ded the higher centers of the brain
which new ideas were conceived
past experiences were recorded.

Which factor played the most im-
tant role in the evolution of human
lligence? Was it tools? Lan-
ge? Or the pressures of the Ice
? No one can tell; all worked to-
her through natural selection to
duce the dramatic increase in the
of the brain that has been re-
ded in the fossil record of the last

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Caprice Classic with available Estate equipment.

GM

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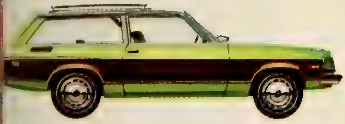
enter for wagons.



Vega with available Estate equipment

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million years. The human body shaped into its modern form du that same period. Now brain body were complete. Together made a new and marvelous creat charged with power, intellige and creative energy. Its wits had t honed by the fight against hun cold, and natural enemies; its f had been molded in the crucibl adversity. In the annals of antl pology, its arrival is celebrated b change in name, from *Homo e tus*—the man who stands erect- *Homo sapiens*—the man of wisd

Today, human beings rest at summit of creation on the earth. W does the future hold in store for extraordinary animal? Perhaps mans will become extinct, as *A tralopithecus* did; 90 percent of the forms of life that have existec the earth have become extinct. they may survive unchanged into distant future, living fossils like oyster. This fate may already be u us, for the human body has chan very little in several hundred th sand years, and the human brain not changed, at least in gross size the last hundred thousand years. organization of the brain may h improved in that period, but amount of information and wi that can be crammed into a crani of fixed size is limited. The fact the brain is no longer expanding, a half a million years of explos growth, suggests that the devel ment of the animal we call hur may be a nearly completed chapte evolution.

This does not mean that the ev tion of intelligence is over. I thin is reasonable to assume that hur beings are not the last word in evolution of intelligence on the ea but only the rootstock out of wh a new and higher form of life evolve, to surpass our achieveme as we have surpassed those of *A tralopithecus*. The history of life s ports this conclusion, for it show seemingly inexorable trend tow greater intelligence in the higher mals. Apparently, among all trait a living organism, none has gre survival value than the flexible, in vative response to changing co tions that we call the intelligence seems unlikely that this trend in e lution, which has persisted for m millions of years, would be ter nated suddenly at the particular le of mental achievement that we human. If the past is any guide to

re, humankind is destined to have
ll more intelligent successor.
/hat form will that posthuman in-
gence take? A common picture
it as a creature very much like
elves, but with an even larger
n. Some futurists, however, be-
e this point of view is too narrow.
y see powerful forces of evolution
work—cultural rather than or-
ic—that could lead to a com-
ely different form of intelligence.
se experts are impressed by the
losively rapid development of in-
gent machines. They view the
ent difference between human
artificial intelligence as one of de-
, not of kind, and predict that the
between humans and machines
be crossed about the year 2000.
ne recent developments in the
puter industry might give us
se for thought before we reject
r vision.
'o understand the significance of
e developments, compare the hu-
ı brain with existing computers.
average brain weighs three
nds, consumes electrical energy
ne rate of 25 watts, and occupies
lume of one-tenth of a cubic foot.
hin this small volume, the brain
ses between ten billion and one
dred billion items of information.
most powerful computers in use
ay have memories that hold a few
lion items of immediately accessi-
information. Although the capac-
of such a machine is far less than
of the brain, it consumes about
,000 watts of electrical power,
occupies hundreds of cubic feet
pace. Scaling today's computers
vard in size, a machine matching
human brain in memory capacity
ıld consume electrical energy at
rate of one billion watts—half the
put of the Grand Coulee Dam—
occupy most of the space in the
pire State Building. Its cost would
n the neighborhood of $10 billion.
machine would be a prodigious
ficial intelligence, but it would be
y a clumsy imitation of the human
in.
'he qualitative superiority of the
in is even more striking than its
pactness. Every brain cell is di-
ly connected to many other cells,
ome cases to as many as 100,000.
a result, when we send a conscious
pulse down to the recesses of the
mory to summon forth a point of
rmation, the cells in which this
rmation is stored communicate
a subconscious level with thou-

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sands of other cells, and a wealth of associated images pours out at the conscious level of thought. The fruits of the subconscious activity are intuitive insight, flashes of perception, and creative inspiration, all made possible by countless connections among the cells of the human brain. These connections from one cell to another explain much of the brain's extraordinary power.

The computer memory, in contrast, is like a set of pigeonholes stacked against a wall, with no thinking capacity in any pigeonhole, and no connections from one hole to another. Information can be placed in a pigeonhole or taken out of it, but there are no associations and thinking goes on elsewhere.

It is plain that computers are minibrains in comparison with the product of millions of years of human evolution. On almost every count, the world's most powerful electronic brains are hopelessly inadequate in comparison with the one-tenth of a cubic foot of gray matter that resides in the human cranium.

In that case, why is the computer useful? The answer lies in its speed. The latest machines do sums a hundred million times faster than the human brain, performing as many as ten million additions each second, whereas the brain requires a second or more to do a single addition. Speed gives the computer its great power in dealing with problems such as forecasting the weather or keeping track of airline reservations. Yet its small memory and primitive thinking circuits render it powerless to deal with the variety of exercises in reasoning that any human being easily masters in the course of an ordinary day.

But the intelligent machine, still in its infancy, is evolving rapidly. The experience of the last three decades indicates that computer capability increases by a factor of ten every seven or eight years—a period that, in the jargon of the specialists, constitutes a computer generation. This seems a reliable rule of thumb for projecting the state of the computer art into the future. The record is clear. The first generation of computers, based on vacuum tubes, came into use in 1950. The second generation, which appeared about 1958, was based on transistors and was ten times larger and faster. The third generation—ten times faster still—thinks with the aid of "chips," tiny squares of metal, which replaced both the bulky transistor and the vacuum tube. Large third-generation computers, built around chips, appeared in 1966. The first large computer of the fourth generation was introduced at the Goddard Institute For Space Studies in 1973. That machine is also based on chips, but in it a single chip holds the equivalent of one thousand vacuum tubes. This is the powerful computer previously compared to the human brain.

The fifth generation of computers will come into use about 1981. One important element in these machines will be a "bubble memory," a new device a thousand times more compact than its predecessors. With the reduction in volume offered by the bubble memory, a hypothetical machine with the capacity of the human memory would shrink from the volume of a skyscraper to that of a suite of offices.

Still more revolutionary electronic devices are in an experimental stage. One has the capacity of an entire computer plated on a single chip roughly one-quarter inch across. This chip-sized computer contains the seeds of a conceptual advance that may bridge the gap between today's relatively simpleminded computer and the elaborate three-dimensional tracery of nerve cells in the human brain. Transistors and other circuit elements are fitted so closely together that it becomes feasible to combine thinking circuits and memory units on a single chip. Thus, one cell in the computer's memory bank can both remember and reason.

This combination of functions is extremely important because a memory chip with thinking capacity can be wired to send out instructions to neighboring chips. Hence, when an instruction is sent to the memory bank to call out the contents—say, an individual's name—stored in a particular cell or group of cells, the memory cells directly involved can send out inquiries to neighboring cells for related information and produce for the computer user a larger body of information than the user had in mind.

Here we come close to the kind of remembering by association that constitutes such a powerful element in human reasoning. The brain responds to a simple request for information with a large variety of material, all connected with the summoned entity by associations stretching way back into past experience. The thinking process is enormously facilitated by the richness of the brain's respon such requests, working at the sub scious level by means of the t sands of connections between i vidual brain cells in a manner a poorly understood. The compute 1977 are simplistic organisms wit capability for subconscious thou but the new advances in electro which will lead to memory-c thinking on a single chip, will ch all that.

If the rule of thumb for projec the state of the computer art conti to hold, then two more generatior computer improvement bey 1981—bringing us to about 19 should produce a desk-sized mac that has the memory capacity some of the thinking power of human brain. Another generatio two will see a quasi-human int gence that can be fitted into a suitc

These intelligent machines will doubtedly be constructed becaus will need their help in managing complex world of the next cent Programmer-tutors will spend haps twenty years working with machine, filling its memory knowledge and basic skills and developing its ability throug graded series of exercises. When machine's education is complete mind will resemble that of a hi trained Ph.D., with limited ex ence but strong reasoning power the beginning of the twenty-first tury, we will come to live in sy otic union with these products of creativity, looking to them for specialized, but exceedingly t ough, explorations of complex p bilities that cannot be matched by human brain. Lacking our biolog inheritance, they will also lack psychological insights; but if we in a mood for a cerebral conversat we will find them to be stimula partners.

What about the twenty-second tury? Or the twenty-third? There no limits yet in sight for the ri curve of machine intelligence. leader in artificial intelligence search, Marvin Minsky of MIT, lieves that a machine will ultima come into being with "the genera telligence of an average human b . . . the machine will begin to edu itself . . . in a few months it wil at genius level . . . a few months a that its power will be incalculabl And after that? Minsky says, "I are lucky, they might decide to k us as pets."

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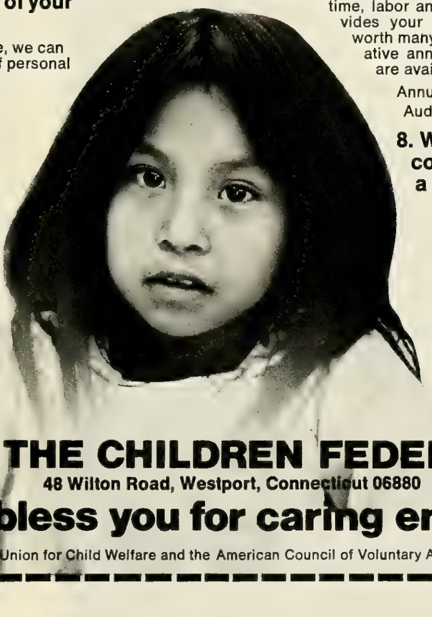

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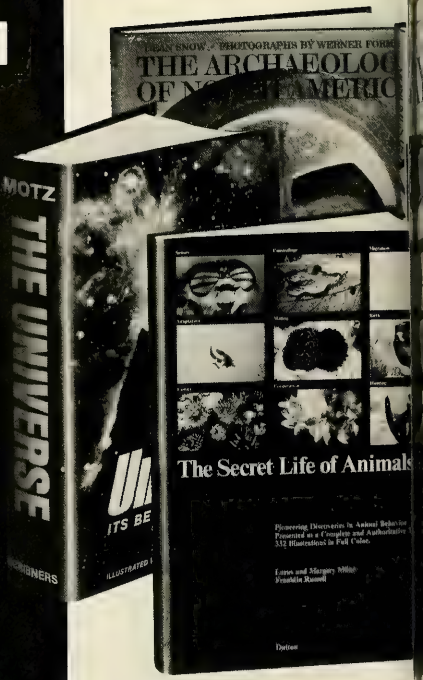
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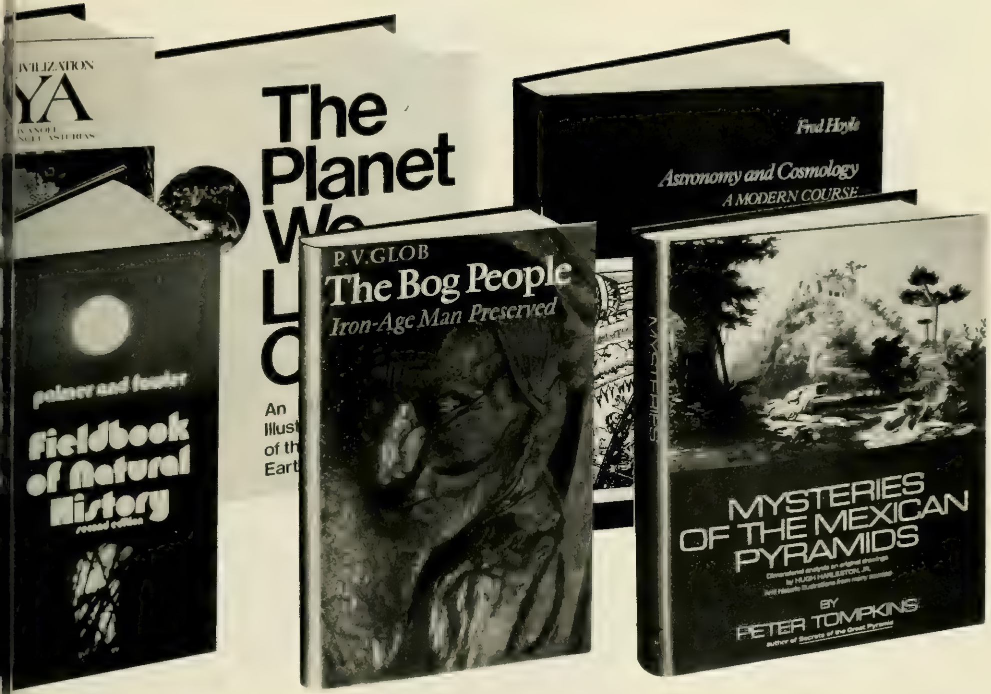

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by Stephen Jay Go

The Return of Hopeful Monsters

If you start early enough, the creation of monstrous forms is not difficult

Big Brother, the tyrant of George Orwell's *Nineteen Eighty-Four,* directed his daily Two Minutes Hate against Emmanuel Goldstein, enemy of the people. When I studied evolutionary biology in graduate school during the mid-1960s, official rebuke and derision focused upon a geneticist named Richard Goldschmidt. Although the year creeps up on us, I trust that the world will not be in Big Brother's grip by 1984. I do, however, predict that during the next decade Goldschmidt will be largely vindicated in the world of evolutionary biology.

Goldschmidt was a Jewish refugee from Hitler's decimation of German science. He spent the remainder of his career at Berkeley, where he died in 1958. His views on evolution ran afoul of the great neo-Darwinian synthesis forged during the 1930s and 1940s and continuing today as a reigning, if slightly insecure, orthodoxy. Contemporary neo-Darwinism is often called the "synthetic theory of evolution" because it united the theories of population genetics with the classical observations of morphology, systematics, embryology, biogeography, and paleontology.

The core of this synthetic theory merely restates the two most characteristic assertions of Darwin himself: first, that evolution is a two-stage process (small, random variation as the raw material; natural selection as a directing force); secondly, that evolutionary change is generally steady, gradual, and continuous.

Geneticists can study the gradual increase of favored genes within populations of fruit flies in laboratory bottles. Naturalists can record the steady replacement of light moths by dark moths as industrial soot blackens the trees of Britain. Orthodox neo-Darwinians extrapolate these even and continuous changes to the most profound structural transitions in the history of life: by a long series of insensibly graded intermediate steps, birds are linked to reptiles, fish with jaws to their jawless ancestors. Macroevolution (major structural transition) is nothing more than microevolution (flies in bottles) extended. If black moths can displace white ones in a century, then reptiles can become birds in a few million years by the smooth and sequential summation of countless changes. Change of gene frequencies in local populations is an adequate model for all evolutionary processes—or so the current orthodoxy states.

Many evolutionists view strict continuity between micro- and macroevolution as an essential ingredient of Darwinsim and a necessary corollary of natural selection. Still, as I argued last month, Thomas Henry Huxley divided the two issues of natural lection and gradualism and war Darwin that his strict and unw ranted adherence to gradualism mi undermine his entire system. The f sil record with its abrupt transiti offers no support for gradual chan and the principle of natural select does not require it—selection operate rapidly. Yet the unnecess link that Darwin forged became central tenet of the synthetic theo

Goldschmidt raised no objectio the standard accounts of microevo tion; he devoted the first half of major work, *The Material Basis Evolution* (Yale University Pre 1940), to gradual and continu change within species. He br sharply with the synthetic theo however, in arguing that new spec arise abruptly by discontinuous va tion, or macromutation. He admit that the vast majority of macromu tions (for example, two-head turtles and two-legged sheep) co only be viewed as disastrous—th he called "monsters." But, Go schmidt went on, every once i while a discontinuous macromutat might, by sheer good fortune, ad an organism to a new mode of li a "hopeful monster" in his ter nology. Macroevolution proceeds the rare success of these hopeful m sters, not by continuous sm changes within populations.

I want to argue that defenders the synthetic theory made a caricat

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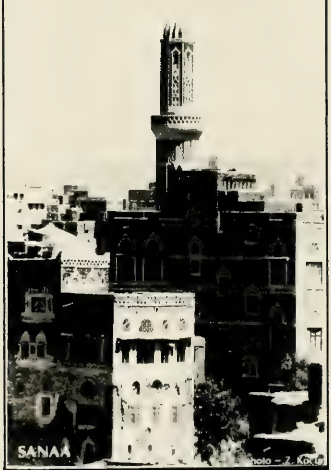

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of Goldschmidt's ideas in estab ing their whipping boy. I shall defend everything Goldschmidt s indeed, I disagree fundamen with his claim that abrupt macro lution discredits Darwinism. Goldschmidt, too, failed to l Huxley's warning that the essenc Darwinism—the control of evolu by natural selection—does not quire a belief in gradual change.

As a Darwinian, I wish to def Goldschmidt's postulate that ma evolution is not simply microev tion extrapolated and that m structural transitions can occur idly without a smooth series of ir mediate stages. I shall proceed by cussing three questions: (1) can a sonable story of continuous cha be constructed for all macroev tionary events? (my answer shal no); (2) are theories of abrupt cha inherently anti-Darwinian? (I s argue that some are and some aren (3) do Goldschmidt's hopeful m sters represent the archetype of ap tasy from Darwinism, as his cri have long maintained? (my ansv again, shall be no).

All paleontologists know that fossil record contains precious li in the way of intermediate for transitions between major groups characteristically abrupt. Gradual usually extract themselves from dilemma by invoking the extreme perfection of the fossil record- only one step in a thousand survi as a fossil, geology will not rec continuous change. Although I re this argument (for reasons discus in last month's column), let us gi the traditional escape and ask a ferent question. Even though we h no direct evidence for smooth tra tions, can we invent a reasonable quence of intermediate forms, that viable, functioning organisms, tween ancestors and descendants? what possible use are the imperf incipient stages of useful structur What good is half a jaw or hal wing? The concept of "preadap tion" provides the conventional swer by permitting us to argue t incipient stages performed differ functions. The half jaw worked p fectly well as a series of gill-suppo ing bones; the half wing may ha trapped prey or controlled body te perature. I regard preadaptation as important, even an indispensab concept, and recently defended (*Natural History*, January 1977) discussing the evolution of a de

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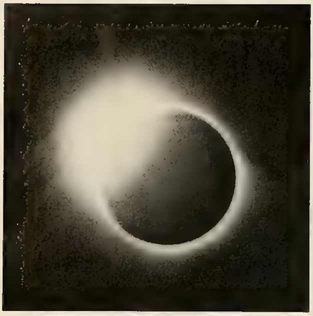

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"fish" on a clam's rear end. But a plausible story is not necessarily a true one. And, in any case, the issue is not, can preadaptation save gradualism in some cases, but rather, does it permit us to invent a tale of continuity in most or all cases? I submit, although it may only reflect my lack of imagination, that the answer is no, and I invoke two recently supported cases of discontinuous change in my defense.

On the isolated island of Mauritius, former home of the dodo, two genera of boid snakes (a large group that includes pythons and boa constrictors) share a feature present in no other terrestrial vertebrate: the maxillary bone of the upper jaw is split into front and rear halves, connected by a movable joint. In 1970, my friend Tom Frazzetta published a paper entitled "From Hopeful Monsters to Bolyerine Snakes?" (*American Naturalist,* vol. 104). He considered every preadaptive possibility he could imagine and rejected them in favor of discontinuous transition. How can a jawbone be half broken?

Many rodents have cheek pouches for storing food. These internal pouches connect to the pharynx and probably evolved gradually under selective pressure for holding more and more food in the mouth. But the Geomyidae (pocket gophers) and Heteromyidae (kangaroo rats and pocket mice) have invaginated their cheeks to form external fur-lined pouches with no connection to the mouth or pharynx. What good is an incipient groove or furrow on the outside? Did such hypothetical ancestors run about three-legged while holding a few scraps of food in an imperfect crease with their fourth leg? Charles A. Long (*American Naturalist,* 1976), has recently considered a suite of preadaptive possibilities (external grooves in burrowing animals to transport soil, for example) and rejected them all in favor of discontinuous transition. These tales, in the "Just-So Stories" tradition of evolutionary natural history, do not prove anything. But the weight of these, and many similar cases, long ago wore down my faith in gradualism. More inventive minds may yet save it, but concepts salvaged only by facile speculation do not appeal much to me.

If we must accept many cases of discontinuous transition in macroevolution, does Darwinism collapse to survive only as a theory of minor adaptive change within species? essence of Darwinism lies in a si phrase: natural selection is the ative force of evolutionary cha No one denies that natural selec will play a negative role in el nating the unfit. Darwinian the require that it create the fit as v Selection must do this by building aptations in a series of steps, pres ing at each stage the advantage part in a random spectrum of ger variability. Selection must supe tend the process of creation, not toss out the misfits after some o force suddenly produces a new cies, fully formed in pristine per tion.

We can well imagine such a r Darwinian theory of discontinu change—profound and abrupt ge ic alteration luckily (now and th making a new species all at o Hugo de Vries, the famous Du botanist, supported such a the early in this century. But these tions seem to present insuperable ficulties. With whom shall Mine from Zeus's brow mate? All her r tives are members of another spec What is the chance, even in fullness of time, to produce Mine rather than a deformed mons Major disruptions of entire gen systems do not produce favored— even viable—creatures.

But all theories of discontinu change are not anti-Darwinian, Huxley pointed out nearly 120 ye ago. Suppose that a discontinu change in adult form arises fro small genetic alteration. Problems discordance with other members the species do not arise, and the lar favorable variant can spread thro a population in Darwinian fashi Suppose also that this large cha does not produce a perfected form at once, but rather serves as a "ke adaptation to shift its posses toward a new mode of life. Contin success in this new mode may requ a large set of collateral alteratio morphological and behavioral; th may arise by a more traditional, gr ual route once the key adaptat forces a profound shift in select pressures.

Defenders of the modern synthe have cast Goldschmidt as Goldst by linking his catchy phrase—ho ful monster—to non-Darwinian tions of immediate perfection by p found genetic change. But this is what Goldschmidt maintained. fact, his mechanism of discontinu

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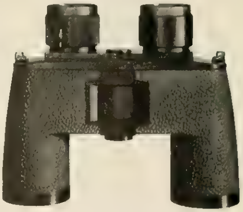

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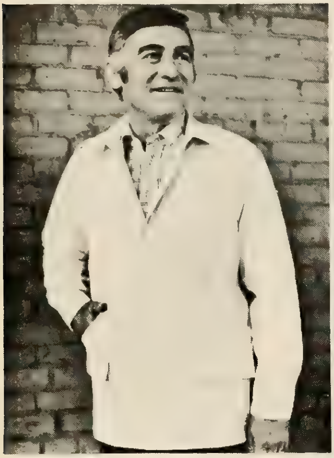

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in adult forms relied upon a notion of small underlying genetic change. Goldschmidt was a student of individual development. He spent most of his early career studying geographic variation in the gypsy moth, *Lymantria dispar*. He found that large differences in the color patterns of caterpillars resulted from small changes in the timing of development: the effects of a slight delay or enhancement of pigmentation early in growth were enlarged through ontogeny and led to profound differences among fully grown caterpillars.

Goldschmidt identified the genes responsible for these small changes in timing, and demonstrated that large final differences reflected the action of one or a few "rate genes" acting early in growth. He codified the notion of a rate gene in 1918 and wrote twenty years later:

> The mutant gene produces its effect . . . by changing the rates of partial processes of development. These might be rates of growth or differentiation, rates of production of stuffs necessary for differentiation, rates of reactions leading to definite physical or chemical situations at definite times of development, rates of those processes which are responsible for segregating the embryonic potencies at definite times.

In his infamous book of 1940, Goldschmidt specifically invokes rate genes as the makers of hopeful monsters: "This basis is furnished by the existence of mutants producing monstrosities of the required type and the knowledge of embryonic determination, which permits a small rate change in early embryonic processes to produce a large effect embodying considerable parts of the organism."

In my own, strongly biased opinion, the problem of reconciling evident discontinuity in macroevolution with Darwinism is largely solved by the observation that small changes early in embryology accumulate through growth to yield profound differences among adults. Prolong the high prenatal rate of brain growth into early childhood and a monkey's brain moves toward human size. Delay the onset of metamorphosis and the axolotl of Lake Xochimilco reproduces as a tadpole with gills and never transforms into a salamander. (See my book *Ontogeny and Phylogeny* [Harvard University Press, 1977] for a compendium of examples, and pardon me for the unabashed plug.) As Long argues for the external cheek pouch: "A genetically controlled developmental inversion of the cl
pouch may have occurred, recur
and persisted in some populati
Such a morphological change w
have been drastic in effect, tur
the pockets 'wrong side out' (f
side in), but nevertheless it woul
a rather simple embryonic chang

Indeed, if we do not invoke dis
tinuous change by small alteratio
rates of development, I do not
how most major evolutionary tra
tions can be accomplished at all. I
systems are more resistant to b
change than the strongly diffe
tiated, highly specified, comp
adults of "higher" animal grou
How could we ever convert a rhi
eros or a mosquito into someth
fundamentally different. Yet tra
tions between major groups m
have occurred in the history of li

Sir D'Arcy Wentworth Thomps
classical scholar, Victorian pr
stylist, and glorious anachronism
twentieth-century biology, dealt v
this dilemma in his classic treatise
Growth and Form.

> An algebraic curve has its fundame
> formula, which defines the family
> which it belongs. . . . We never thin
> "transforming" a helicoid into an el
> soid, or a circle into a frequency cu
> So it is with the forms of animals.
> cannot transform an invertebrate in
> vertebrate, nor a coelenterate int
> worm, by any simple and legitimate
> formation. . . . Nature proceeds from
> type to another. . . . To seek for steppi
> stones across the gaps between is to s
> in vain, forever.

D'Arcy Thompson's solution was
same as Goldschmidt's: the transit
must occur in simpler and more si
lar embryos of these highly diverg
adults. No one would think of tra
forming a starfish into a mouse,
the embryos of some echinode
and protovertebrates are nearly id
tical.

The year 1984 will mark the 12
anniversary of Darwin's *Origin*,
first major excuse for a celebrat
since the centenary of 1959. I h
that our "new speaking" seven ye
hence will be neither dogma nor v
uous nonsense. If our entrenched
priori preferences for graduali
begin to fade by then, we may fin
begin to welcome the plurality of
sults that nature's complexity p
vides.

Stephen Jay Gould teaches biolo
geology, and the history of scienc
Harvard University.

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Social Commentary from the Cemetery

by Edwin S. Dethlefsen and Kenneth Jensen

From colonial times to the present, gravestones have reflected American attitudes toward death, family, and society

An old and popular New England tradition, for resident and visitor alike, is a relaxing walk through one of our historical cemeteries. In the relief-sculptured death's heads and winged cherubs that adorn eighteenth-century slate headstones, we may admire a fine old folk craft or the more energetic may attempt to decipher the sometimes imaginative epitaphs. With appreciation for the artistry of our colonial forebears may come a sense that the graveyard is an oasis of stability in a world that is otherwise changing at a rapid rate. Stable as it may appear, the old cemetery is a remarkably sensitive record of change, representing successive generations, each with its own distinctive set of values and ways of perceiving the environment.

Haphazard rows of slate tablets give way in time to simple marble tablets bearing urn and willow motifs. The latter in turn lose popularity to marble gravestones of a variety of sizes and shapes and often arranged in groups or family plots. The heyday of ornate marble memorials lasted into the 1920s, when measured rows of uniformly sized granite blocks replaced them. The most recent development in cemeteries has produced parks of rolling lawns, their necropolitan smoothness scarcely broken by rows of slight indentations in the grass, where small bronze or concrete markers record the names and numbers of those who lie beneath.

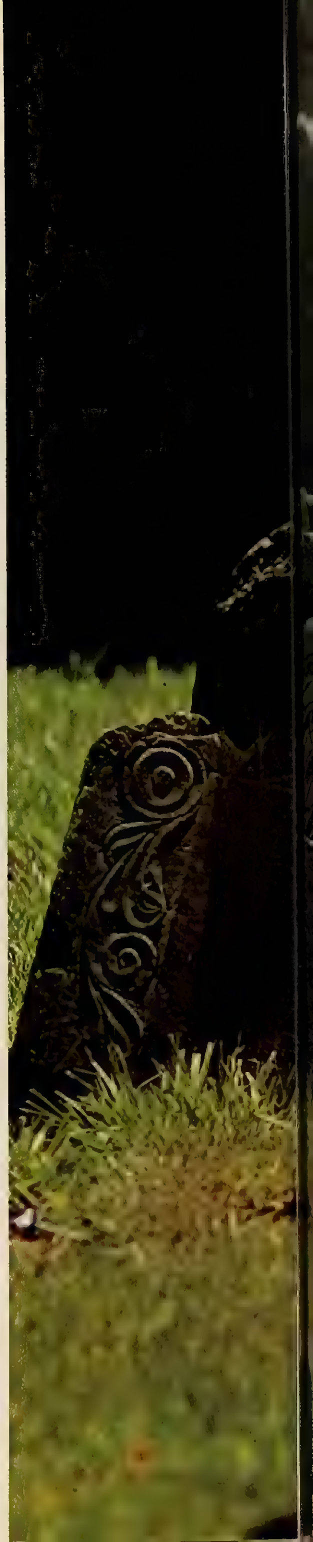
Surely these are vast changes to have accrued within a mere few centuries. The differences among Egyptian, Greek, and Roman architecture are hardly more diverse, even though they involve millennia, as well as the cultures of different nations.

The early colonists saw and dealt with their world in specific ways. The winged death's head, the most popular motif before 1760, represented the mortal remains of the deceased and was followed by winged cherubs representative of the immmortal soul. By 1800 the ethereal, but impersonal, urn and willow motif had replaced all other pictorial references to the deceased individual.

Epitaphs on these stones of the late Revolutionary and early Federalist periods tend to memorialize the living personality rather than to mark its demise. One typical epitaph of this period, from Shrewsbury, Massachusetts, reads:

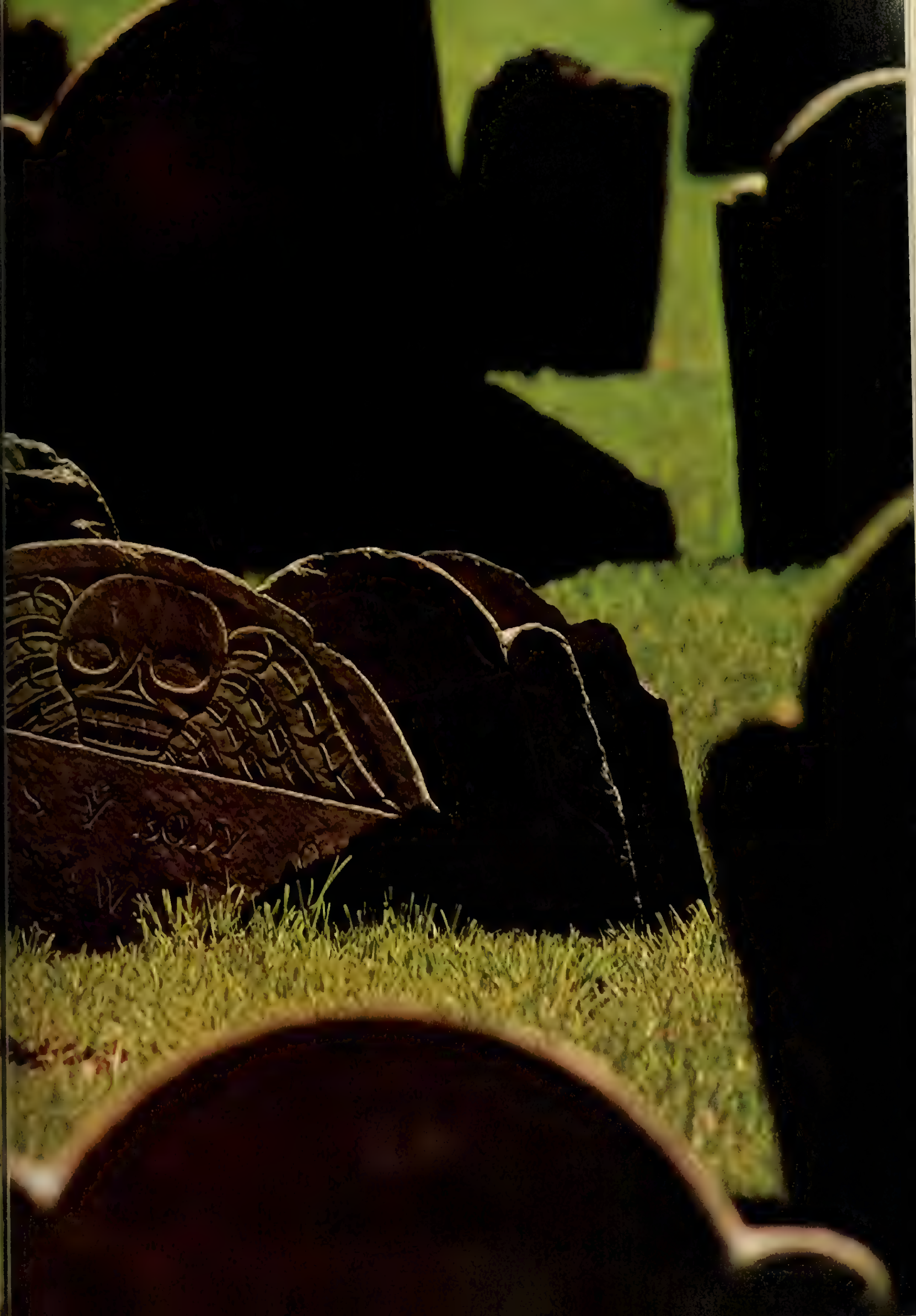
> *In Memory of Mrs. Hannah,*
> *Wife of Mr. Simeon Ide,*
> *Who Died April ye 18th, 1792*
> *in ye 22nd year of her age.*
> *Endear'd to her friends by those*
> *amiable Virtues, which dignify*
> *human nature, and renders it*
> *desirable, even with its miseries.*

But many gravestones of the earlier, colonial days speak not at all of memories. Consider this one in Lee,



In colonial New England cemeteries, such as Boston's Granary Burying Ground, most gravestones are adorned with sculptured death's heads.

S. Green-Armytage, Photo Researchers



IN GOD WE TRUST.
FRIENDSHI AND TRUTH.
NIEL CLARK
DIED
SEPT. 6,
1856,
T. 48.

v Hampshire, as a model of terse-
; and finality:

Here lies ye body of
Hanna Joannes
Wife of Ebeneezer Joannes,
Ages 31 years & 5 mo
Died May 4, 1745.

lthough not all inscriptions of this
od were so short, many include
nore than vital statistics, with an
asional phrase to remind us that
th awaits us all.

such sentiments and attitudes can
nge so much in a few generations,
v can we hope to understand and
re the views our ancestors had of
worlds they lived in? Literary his-
ans may explain the psychology
our predecessors by examining
tten descriptions and charac-
zations, but in doing so, they must
e with or ignore the lurking suspi-
n that writers were almost always
elect group whose words did not
essarily reflect the attitudes of the
nmon folk. On the other hand, ev-
one dies, and survivors of the de-
sed memorialize that event with
vestones and epitaphs reflecting
ial attitudes of the times.

he lack of individuality in our
dern cemeteries, much to the re-
of those of us seeking a return to
nanistic or, perhaps, quainter val-
, signals the continuation of a
cess begun decades ago—this
cess is in itself a statement about
nge in American culture. If evi-
ce of folksy individualism has dis-
eared from the cemetery, along
h the Edwardian voluptuousness
ts marble memorials, there must
reason or a complexity of reasons
the disappearance.

here is more to a gravestone than
design at the top. Many have dis-
tive shapes and arrangements of
rds on them, references to groups
which the deceased was once a
t, and even differences in the ma-
al of which they are constructed.
vestone decorations may vary greatly; often they are incised, but they also come in the form of grave accompaniments such as borders around family or individual plots, planted flowers or shrubbery, plastic or cut flowers and their containers, toys, candles, seashells, and so on. Even the position of the name on the gravestone may be indicative of changing cultural concerns.

While it is esthetically intriguing to examine one gravestone at a time, each memorial is also an integral part of an entire cemetery. The most revealing hints about American culture are the cumulative impressions of the various time and style periods represented in the cemetery.

A colonial or early American gravestone, for example, usually represents only a single individual. Occasional exceptions were children, mother and child, or husband and wife, any of whom may have sometimes shared the same gravestone. In modern community cemeteries from Maine to Florida, however, more than half the gravestones erected since 1950 represent two or more people. Nor is the arrangement random within a family. In more than 90 percent of contemporary gravestones, the shared monument represents a husband and wife. In many instances one member of the couple is still living; in some cases neither spouse is deceased. One elderly cemetery keeper in Florida proudly showed us the plot and stone already engraved with his and his wife's names, which they had carefully selected for their resting place.

We have also observed that in most southern cemeteries, the wife's name on recent gravestones is usually on the right, while in the north the placement of names is quite variable. As a variation on this theme, in some central Massachusetts villages with populations of eastern European descent, wives' names on gravestones consistently occupy positions below those of their husbands. While these observations are so obvious as to have gone largely unnoticed, they are of interest because they represent certain attitudes of contemporary Americans and, as such, demand explanations that may help us interpret evidence of the more distant past.

Colonial and early American husbands and wives were seemingly not greatly concerned about being buried side by side or about who was buried on which side of whom, but they did seem preoccupied with family solidarity, religious fervor, and wealth. This concern extended through the romantic Victorian and post-Victorian eras up to the 1920s.

Obelisks in countless family plots point out the heavenly resting places of those buried in them, with the individual graves marked by rows of simpler stones. Consider this simple, but intriguing, inscription on a large granite block in a Keene, New Hampshire, family plot:

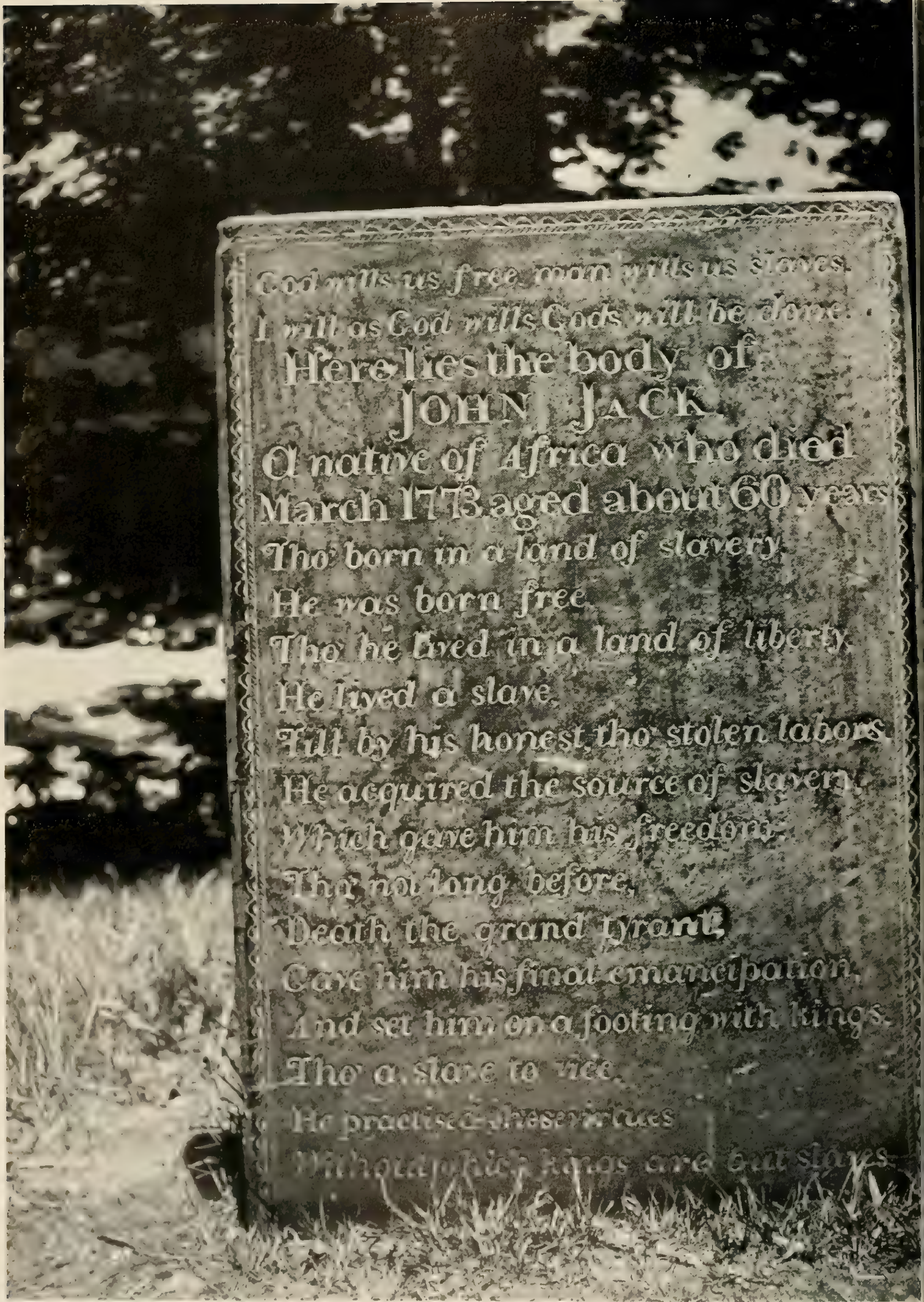
Patrick Cooney
1845
Mary Cantwell
his wife
1855
Lawrence Cooney
1871–1906
Mamie Cooney
1878–1885

While the significance of the arrangements of names on the stone is clear, the pattern of burials within a plot follows no rules. In family plots, husbands and wives rest in opposite corners just as frequently as side by side. Since a large proportion of burials, from colonial times through the 1920s, were in family groupings (more often identifiable as family plots, set off by a fence or border, in the nineteenth and twentieth centuries) there appears to have been a reasonable assurance that wherever one's remains were interred they would be in a friendly neighborhood. As often as not, children and other kin were buried between the remains of spouses, the burials arranged in the chronological order of death more often than according to specific familial relationships.

The appearance of formal family plots in the mid-nineteenth century suggests the social attitudes of the living community. The erection of ornate marble monuments in the family plots of upper-class families, as opposed to the simpler memorials erected by less wealthy people, may be an expression of the increasing social and economic stratification that occurred with the industrial expansion of the nineteenth century. It may also be a result of an increase in population density beyond the point where the deceased, buried at random in the

he mid-nineteenth century,
rble replaced slate as gravestone
terial, allowing opportunities
more elaborate carving. This
mple is in Chelsea, Vermont.

Mill, Photo Researchers



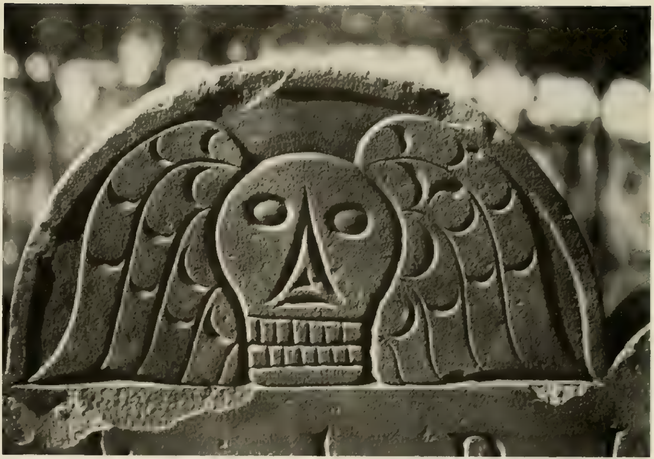
God wills us free, man wills us slaves.
I will as God wills, Gods will be done.
Here lies the body of
JOHN JACK
A native of Africa who died
March 1773 aged about 60 years
Tho' born in a land of slavery
He was born free
Tho' he lived in a land of liberty
He lived a slave.
Till by his honest, tho' stolen labors,
He acquired the source of slavery,
Which gave him his freedom;
Tho' not long before,
Death the grand tyrant,
Gave him his final emancipation,
And set him on a footing with kings.
Tho' a slave to vice,
He practised those virtues
Without which kings are but slaves.

Peter Mill, Photo Researchers

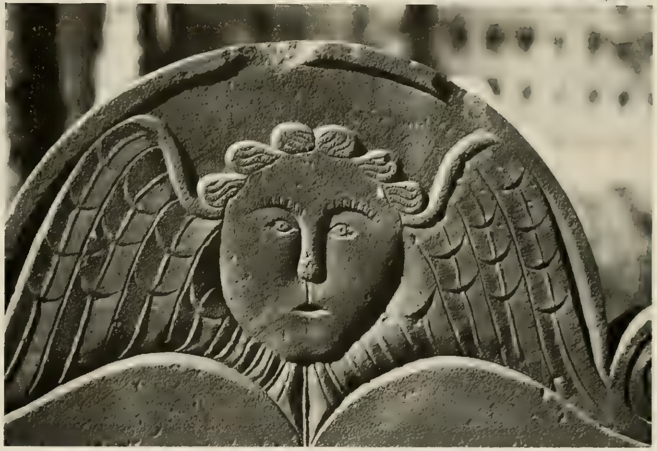
metery, had a reasonable expecta-
on of lying among friends.

As burial patterns changed, so did
avestone materials. Gravestones of
ate, so common during the colonial
riod, gave way by the mid-nine-
enth century to marble. Slate,
hich consists of compacted layers of
one, is fine for engraving but not for
borate sculpture. Also, because of
ate's physical structure, grave-
ones made of that material are nec-
sarily tabular in form and cannot be
sily quarried in blocks like marble.
rk in color, slate invited the tradi-
nal colonial death's head and even
cherub. But the urn and willow
signs and epitaphs of the later pe-
d, which spoke of the eternal life
the soul, demanded a lighter-col-
d material that lent itself to new
erpretations of death. Although the
let form of gravestone, wrought in
rble, survived into the Victorian
riod, it was accompanied by in-
asing numbers of pulpit and obe-
forms, scrolls, crosses, and a va-
ty of statuary, some imported from
rope by wealthier families. While
amily plot often included a large
lisk representative of the family as
whole, the individual grave was
o marked by as decorative a stone
amily finances and the importance
the deceased would permit.

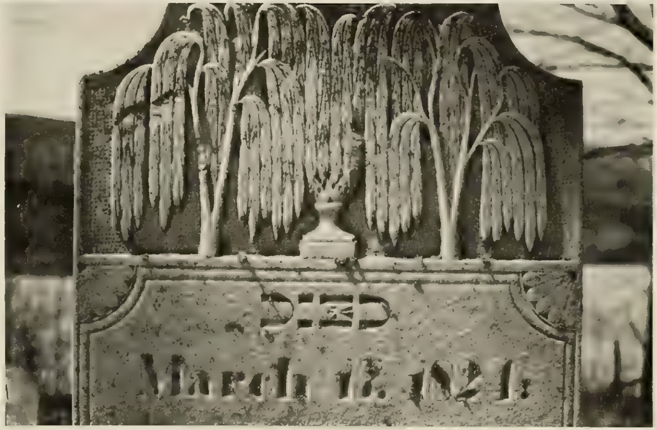
Epitaphs also changed over time.
contrast to the terse epitaphs of the
onial period, such as "He lived
ired and died lamented," those of
Victorian period are generally ei-



Daphne Prior



Daphne Prior



Eric Hartmann, Magnum

st colonial epitaphs are terse
l accepting of death. The one
eft is unusual in a number
espects, not the least being
t it was erected in memory
a slave. The death's head
colonial gravestones, top right,
resentative of humanity's
rtality, gave way in popularity
he more sentimental, immortal
rub, center right, at the end of
eighteenth century, when the
efulness of Puritanism was
ndling. In the 1800s, the urn
willow replaced the cherub,
tinuing the attempt to
y death's reality.

ther eulogistic of the deceased or worshipful of God. Following on the late stages of depersonalized death as exemplified by the urn and willow, the new stone forms and epitaphs appear to deny death altogether. Some typical ones are "Asleep in Jesus," "At Rest," "Not Dead but Sleeping," and "In My Father's House Are Many Mansions." Also common are biographical statements about the deceased. Kin references to wife, son, daughter, and brother are also popular during this period, suggesting that family was taking greater ascendancy over community in the individual values and loyalties of the time.

During this period, references to God were more popular than in the eighteenth century, and the formerly omnipresent urn and willow now competed with lambs, doves, flowers, angels, crowns, crosses, heavenly gates, wreaths, and bibles, all in unprecedented variety. The Victorian era was a time of social and economic differentiation in America, an age of technological and intellectual exploration, and a period when practically any kind of behavior could be blamed on God.

Memorials to the successful are evident far beyond the cemetery as well as in it: witness the solidity and massiveness of public philanthropies of the industrial and economic giants of the time. The burial place of the man who had endowed the local library was usually marked by the biggest monument in the cemetery. The remarkable variety of the Victorian cemetery is itself an assurance that regimentation was not a characteristic of the time, but that competitiveness and creativity were prime virtues.

The 1920s marked the beginning of the modern period in cemetery change. Elaborately sculptured marble and flowery epitaphs rapidly faded in importance, ultimately to be replaced by stark and massive blocks of polished granite, whose impression of durability is far greater than that of either marble or slate. The time was further marked by the full bloom of assembly-line industry in place of handcrafting. It was marked, too, both by the decline of social Darwinism and by a movement toward egalitarianism that has continued its momentum up to the present. The wealthy no longer cared to call attention to their wealth. At the same time, the population of the United States climbed well beyond the hundred million mark. The combination of these last two elements perhaps prompted a general return toward simplicity and uniformity in the cemetery marker and plot. Granite headstones took the form of rectangular blocks inscribed either on their vertical faces, on their flat, slanted, or vaulted tops, or less commonly, on polished horizontal slabs.

Epitaphs are no longer common. When they exist at all, they are usually reduced to a few, remarkably unoriginal phrases such as "At Rest," "In Memory of . . .," or "Gone but Not Forgotten." References to God and heaven are rare. Their repetitiousness conveys the impression that they are employed as secularized formalities, rather than as expressions of primary values. We found one reverent but enterprising couple still living in Florida, however, who had the foresight to inscribe on their already erected gravestone the message, "To God With Love."

Another contemporary type of gravestone is that provided for veterans by the United States government. This takes the form of a simple granite, marble, or bronze tablet and is a specific indicator of what we know to be an important aspect of culture change in America—the increasing paternalism of government.

From cemetery evidence, we are tempted to suggest that the values of modern Americans have gone underground. The distinguishing aspects of the modern cemetery are the succinct gravestone inscriptions and the deliberate pairing of husbands' and wives' names. From the 1950s to the present these stones appear with such frequency that one wonders what has happened to the unmarried people. "Son" and "daughter" have all but disappeared from the cemetery. Infant and child mortality were all but eliminated during the second quarter of this century, so perhaps children simply moved away to establish families of their own.

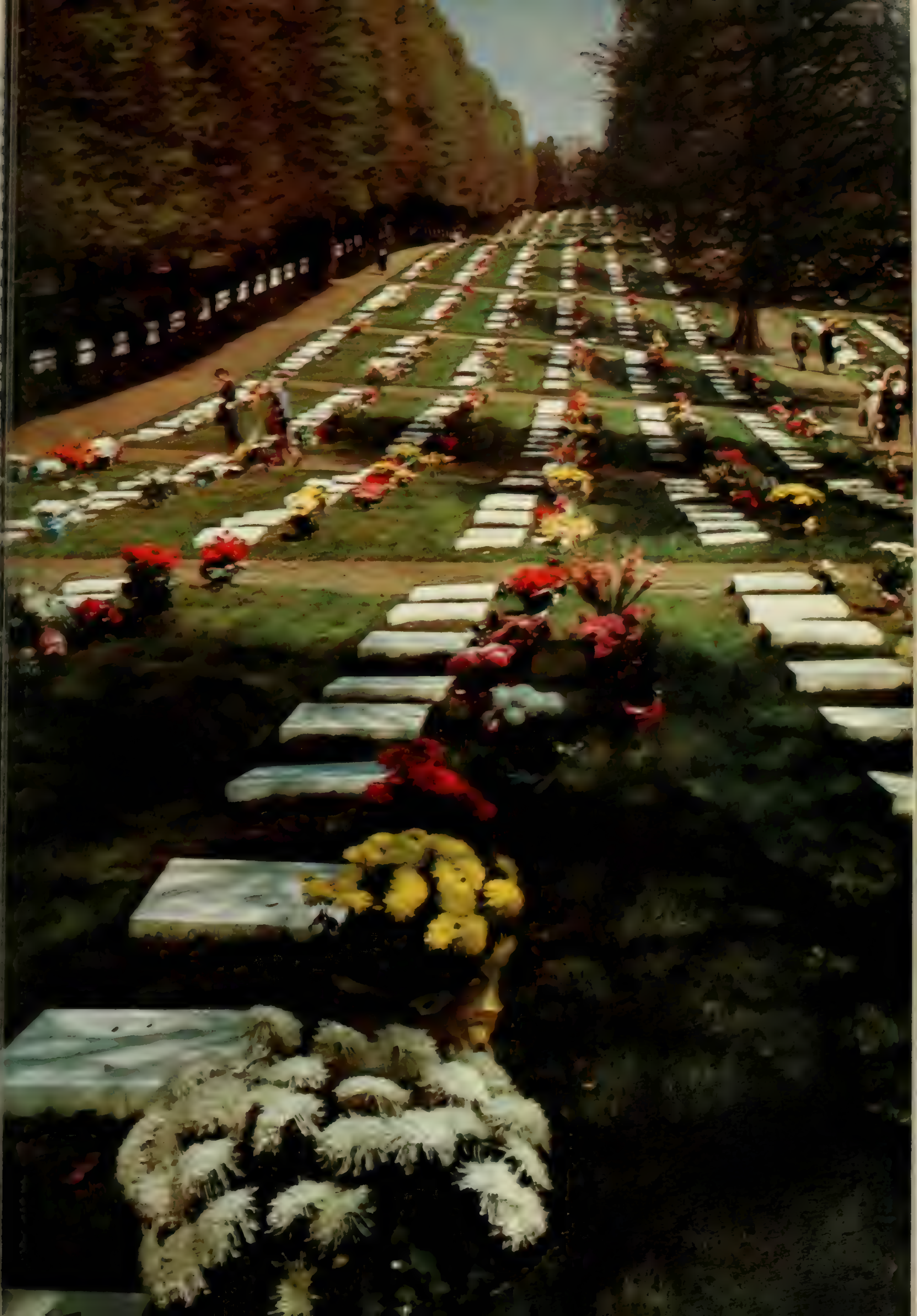
A related side effect of twentieth-century cultural development has been a 30 to 40 percent increase in life expectancy, adding greatly to the number of married couples who, having lived into old age, spend their
later years in childless homes.
consequential increase in the e
tional importance of the wife–
band relationship is clearly visibl
the high proportion of shared me
rials. Nor can we entirely ignore
implication that the devotion to,
dependence upon, God so evi
from the colonial period through
early nineteenth century and the
portance of family in the Victo
period have been replaced in mod
times by an emphasis on a strong
durable husband–wife bond.

Most of our historical commu
cemeteries are fully occupied, and
remainder are nearly so. The era
community cemeteries that be
with the Pilgrims is thus at an e
Few of us will be buried among
ancestors; this in itself represent
change in our view of death and
associated emotions and ritu
Large numbers of people are n
buried in memorial parks, where
succession of change in mortuary a
tude is again evident in the alm
total denial of individuality. Inste
emphasis is on a peaceful, quiet en
ronment, where the dead may res
all but anonymity in the egalitar
ranks of a multistoried mausoleum
in a memorial lawn, marked only
a flat tablet set at ground level to all
unimpeded passage of a lawnmow

Because nostalgia is often a ple
ant emotion, many of us deplore
passage of the historical cemete
But progress and culture travel ha
in hand. While the old commun
cemetery remains a quiet and pleas
place in which to meditate about
lives of those who went before us,
expansion of the memorial park is
inevitable as was the replacement
marble by granite. The new cemete
is but another product of our cultu
adjustment, and as such, future ge
erations of strollers will find it, to
an absorbing place in which to lo
for, and think about, the lives of the
predecessors.

The community cemetery is an enti
of the past. As families have lo
their geographic cohesivenes
modern gravestones ha
lost much of their individualit

Frank Miller, Photo Researc



Monarch Migration

by Lincoln P. Brower

A butterfly weighing a fraction of an ounce flies thousands of miles to a recently discovered wintering spot in Mexico

The monarch butterfly belongs to the Danaidae (or milkweed butterflies), a family that occurs throughout tropical regions of the world. Most of the species of this family lay their eggs only on milkweed plants. After hatching, a monarch caterpillar voraciously consumes the milkweed leaves, passes through five larval stages in about two weeks, undergoes metamorphosis into a chrysalid, and about one week later emerges as an adult butterfly. After about three days, adults are ready to mate and a new generation begins. The rate of development is temperature dependent, so that the number of generations varies from year to year.

During the past several million years, milkweeds underwent a remarkable evolutionary diversification in North America. Across the continent, including Mexico, there occur no less than 108 species in the genus *Asclepias* alone. This array of milkweeds represented a vast potential food supply for the danaid butterflies. However, these insects evolved in tropical climates, and no stage of any danaid butterfly—egg, larva, chrysalid, or adult—is known that can survive prolonged freezing temperatures such as those that occur in temperate North America. Breaking this climatic barrier was a major challenge, and the monarch, *Danaus plexippus*, is unique in being the only species in its family that has succeeded. Having evolved the ability to migrate, the monarch is able to exploit the North American summer food supply of milkweeds and then retreat southward to overwinter in areas free from excessive cold.

The migration of the monarch is very different from that of birds because the individual butterflies that fly south in the fall are several generations removed from their ancestors that flew north the previous spring. Their annual return to the overwintering grounds is thus a complex, inherited behavior pattern in which learning plays no role.

The monarch's migration strategy is highly successful; through several short-lived summer generations, of from three to five weeks each, the species builds its populations to immense numbers. Throughout the continent, as fall approaches, the last generation of adult butterflies begins congregating locally, and by mid-September, the monarch populations are in full migration. In the far west, the butterflies fly southward and westward toward coastal sanctuaries from north of San Francisco to Los Angeles. The butterflies congregate in moist groves of Monterey pines or eucalyptus trees far enough from the sea to avoid winter gales, but close enough to protect them from heavy winter frosts. The most famous California overwintering colony is in Pacific Grove, but scores of other sites exist.

Although migration routes and overwintering sites west of the Rocky Mountains are fairly well documented, a long-standing mystery enshrouded the fate of monarch popu-

Monarch eggs are attached to host plants, which nourish the larvae after they hatch. A sticky monarch butterfly egg clings to a bud of an Asclepias grandiflora *milkweed (right side of bud). The egg will hatch in two to four days, depending on ambient temperatures.*

Lincoln P. Brower

ons eastward to the Atlantic coast.
all winter-breeding colonies occur
lorida, but it seemed unlikely that
se could sustain and provide suffi-
nt numbers of butterflies to migrate
thward again in the spring to
opulate the eastern half of the con-
nt. Reports of large movements of
narchs along the Gulf Coast and
thward through Texas during the
had long led scientists to suspect
t the butterflies overwinter some-
ere in Mexico.

uring the winter of 1974, lepi-
pterist Kenneth Brugger, after a
g search, finally solved the mys-
y: at least one vast colony of over-
ntering monarchs occurs high in
mountains of central Mexico.

have long been interested in the
narch butterfly's relationship to
milkweeds from which it derives
sonous chemicals as well as suste-
nce. These poisons, cardiac glyco-
es, provide the butterfly with a
nsiderable measure of protection
inst birds and probably other
dators as well. If a bird eats a mon-
h that has fed on a poisonous milk-
ed, the bird will suffer a bout of
miting. Although it soon recovers,
bird remembers its unpleasant ex-
ience and will not attack monarchs
a long period of time. In our re-
rch, my wife, Christine Moffitt,
I have found that not all monarchs
poisonous; those that are, vary in
ir toxicity to birds. In other words,
re is a palatability spectrum in the
narch, which is determined by the
lkweeds it eats during its cater-
lar stage. Some milkweeds are not
isonous; others are slightly poi-
nous; still others extremely so.

Furthermore, most milkweed spe-
s have a characteristic array of car-
ic glycosides, and it is possible to
ngerprint'' captured wild mon-
hs and by analyzing their chemical
nstituents, determine which spe-
s of milkweed they ingested as lar-
in their natural habitats. Since we

rying amounts of toxic substances
e present in different milkweed
ecies. This monarch caterpillar
feeding on Asclepias eriocarpa,
most toxic species yet tested.

Brower

discovered this remarkable relationship in monarchs from the California overwintering areas, we predicted it would also be true of the butterflies in the Mexican colony. I was thus keen to visit the newly discovered site in Mexico.

In order to protect the overwintering site, in which millions of monarch butterflies cluster in a three- to four-acre area, the research team working there refused to divulge its location, even to other scientists. One of the researchers, Fred A. Urquhart of the University of Toronto, did publish a popular article in which he mentioned the altitude and general location of the site in a mountainous area of northern Michoacán. Armed with this information, and through a long, complicated, tedious, and frustrating piece of detective work involving a number of people, a member of our research team, William Calvert, located a massive overwintering colony on December 31, 1976, which he thought was the same one Brugger had discovered in 1974. Since we have been unable to ascertain whether the two sites are one and the same, we have designated our overwintering colony as ''Site Alpha.'' Our team immediately proceeded to Mexico, and with Calvert in the lead, we headed for the location where he had spotted the colony.

At first, we could not find the butterflies because the day was overcast, and they were inactive. But as we walked farther down a slope, I noticed changes in the patterns of light through the trees and realized that we were in the midst of the overwintering monarchs, occurring in such dense clusters that they vividly altered the appearance of the forest. Our first impressions were overwhelming, not only because of the incredible numbers of butterflies assembled in one location but also because of the profound biological implications of the phenomenon.

Although Site Alpha is more than 100 miles from the sea, its geographic location results in moderating climatic conditions, probably similar to those of the coastal overwintering areas in California. The colony is located in the trans-Mexico volcanic belt, close to the continental divide. The area, at an altitude of more than 9,000 feet, is moist and supports a mature forest community consisting mainly of firs, pines, cypress, and several smaller deciduous tree species. The firs dominate the forest in numbers and size and attain heights of at least 95 feet. Pines and then cypress are the next most abundant trees. The forest floor is carpeted with a lush layer of mosses, and the trees bear many mesic-loving lichens and ferns.

George D Lepp

Adult monarchs feed on nectar, but flowers, such as the lupine, above, are not plentiful at their wintering site in Mexico. Fats, from nectar eaten in the fall, may sustain them.

Even though overwintering occurs during the dry season, the area is high enough that clouds frequently roll across it, and in the evenings the humidity rises to 100 percent. This moisture is important because it protects the monarchs from desiccation when they are immobilized by low temperatures. Three other factors enhance the favorable moisture conditions of the colony: a cool exposure on a north-facing slope, a sheltered location about 200 feet downslope from the windy ridge crest, and proximity to the headwaters of a mountain stream.

We determined that the colony occupied an area of about 3.7 acres. We also estimated the number of butterflies at the site based on data from a study done in California. From autumn 1975 through the spring of 1976, my colleague Paul Tuskes utilized the mark, release, and recapture method in an overwintering grove at Santa Cruz and determined a peak abundance of 92,000 butterflies in February. The density of the butterflies on the trees at Site Alpha was at least ten times greater than at Santa Cruz, and the area was fifteen times as great. By multiplying this difference in area and butterfly density for Mexico by the number of butterflies at Santa Cruz, we obtained a value of 13.8 million butterflies at Site Alpha. This is a very conservative estimate, and we believe it is well within the realm of possibility that there are as many as 100 million butterflies overwintering in this one Mexican locality.

In California, most of the overwintering colonies occur in disturbed habitats with a rather uniform vegetation of either Monterey pine or introduced eucalyptus trees. In contrast, the natural community at Site Alpha has a diversity of tree species, which also vary in size. This provides different substrates for the butterflies and, in turn, results in a variety of cluster shapes, sizes, and organizations.

The scaly cypress leaves seemed to provide the best foothold; these trees were often so profusely covered with monarchs that it was nearly impossible to see the foliage. Some of the smaller trees were actually bowed over by the collective weight of the monarchs. On pines, the butterflies clustered among the needles in such numbers that whole branches seemed covered with jagged ornaments. The shorter needles of the firs provided less grasping surface, and many branches were transformed into surrealistic cylinders of butterflies. The trunks of many trees were also packed with butterflies, all aligned vertically and so close together that they obscured both the bark and the bases of dead branches, which protruded in a seemingly mysterious manner.

At night, early morning, late afternoon, and on overcast days the only movement in the clusters was that of the laden branches swaying gently in the breeze. During these times the monarchs clung tightly to the leaves, branches, and each other, and only the somber colors of their tightly oppressed wings were evident. Because butterflies are virtually dormant at low temperatures, cool periods are times of energy conservation for them.

Since the clustering behavior of the monarch is so controlled by temperature, we decided to study the relationship in more detail. During our stay we measured the temperature range in the center of the colony at heights of approximately 0, 16, and 33 feet. Even though two of the five days were brilliantly clear and three were partly to totally overcast, minimum temperatures ranged from only 42° to 48°F; maximum temperatures from only 56° to 60°. These findings indicated that the site is thermally quite stable and, equally important, that the maximum temperature was at the threshold at which monarchs can fly.

The critical nature of this temperature threshold was underscored one day by an unplanned, macabre incident that occurred when our guide, whom we had left in charge of our experimental equipment, built a fire under the trees. (As it turns out, the local people frequently bring their cattle to the site to feed on the monarchs. To facilitate this practice, the herdsmen build small fires beneath the clusters, and as the smoke rises

Clusters of overwintering monarchs, hung from the trees at Site Alpha in Michoacán, Mexico. Thirty to 100 million may be using the 3.7-acre area, and some clusters are so heavy that the tree branches bend and even break. Overleaf: Monarchs are packed so tightly against a cypress tree that only the outlines of a few branches are visible.

Lee Hedrick
Overleaf photo by George D. Lepp

the monarchs release their grip and drop en masse to the ground.) I arrived on the scene to find a circle of forest floor, about forty-five feet in diameter, covered with layers of butterflies. This was late in the afternoon of a predominantly overcast day with the temperature about 55°. The butterflies flapped helplessly on the ground until they settled into a prolonged thermoregulatory shivering in an attempt to warm their thoracic wing muscles. Because the ambient temperature was too low, most of the butterflies could not attain the critical 59° to 61° that would have enabled them to fly back to a cluster. The next morning nearly all were found to have crawled from a few inches to about three or four feet up onto vertical faces of rocks or small plant stems.

We observed that the butterflies did not form clusters in the tops of the taller trees and reasoned that this decreases their chances of being blown down during cold periods. Another advantage in concentrating the clusters below the canopy became evident on the morning of January 23. In the clearing where we camped there was heavy frost on the ground, but beneath the butterfly trees in the forest the temperature was 42°. Thus, the tall trees not only act as a windbreak but also provide an umbrella against frost. Snowfall is another danger besetting butterflies that are dislodged from the clusters, since it would cover and totally immobilize them.

Although traumatic, our guide's small fire provided valuable scientific information: since the butterflies are unable to return to their clusters if their thoracic temperature is less than about 55°, they are easy prey to mice and other mammalian predators. In fact, numerous dead butterflies were on the ground and looked as if they had been partially eaten by mammals, although hard evidence at Site Alpha has not yet been gathered. At a colony in Montaña de Oro State Park in California, I found several caches of wings beneath sticks and next to tree trunks adjacent to the overwintering trees—clear evidence of mammalian predation.

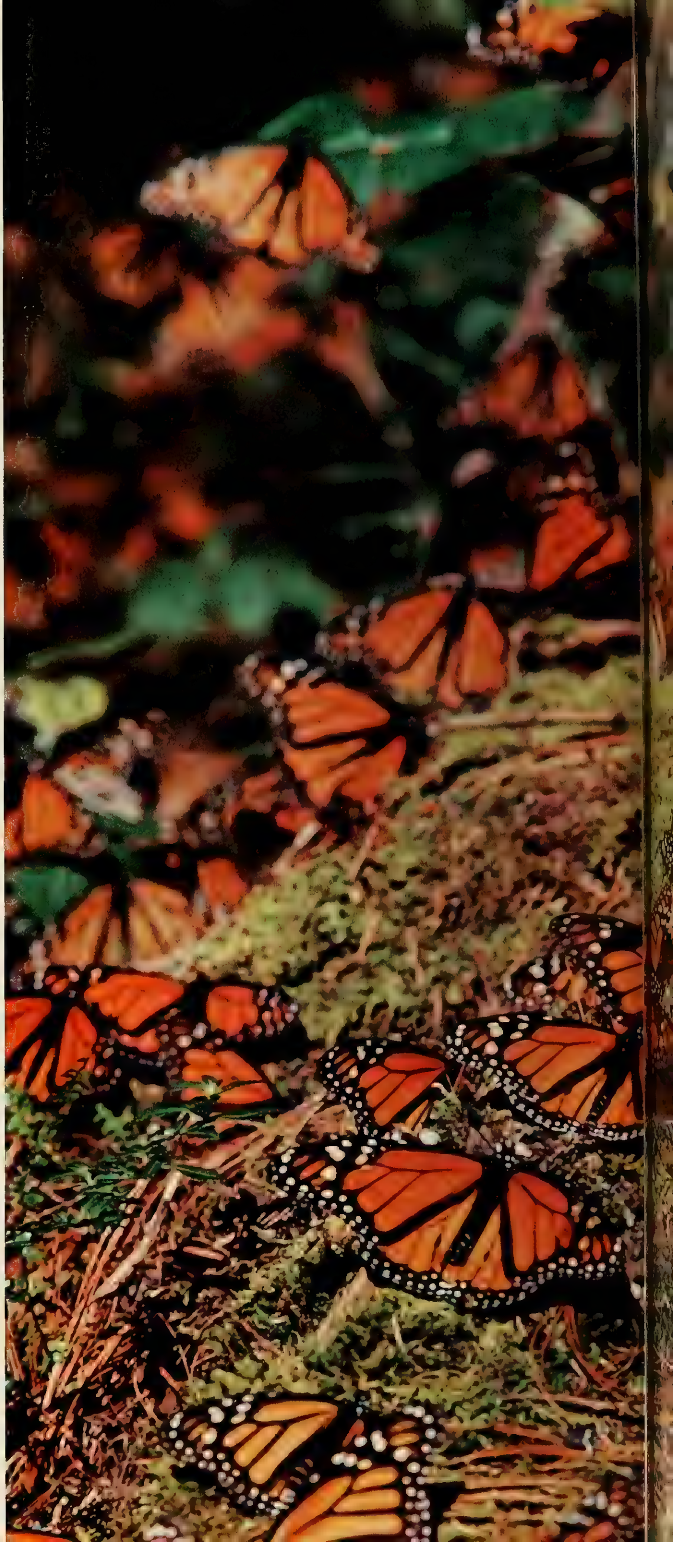
Monarchs are dislodged not only by storms and the possible breaking of branches, but also by birds attacking them or moving about in the trees while engaged in other activities. On

January 26, an overcast day, my assistant Lee Hedrick observed a small flock of Bullock's orioles fly into a fir tree that had no roosting monarchs. From this tree they flew singly to an adjacent fir laden with monarchs and, upon landing, displaced several butterflies, which either dropped to the ground or glided off into the forest. For about forty-five minutes, the birds dislodged occasional butterflies. Although we did not witness ingestion per se, one monarch wing floated down with a small piece of thoracic muscle still attached to it. We also heard the birds snapping their beaks while moving about in the vicinity of the clusters. A year earlier at Santa Cruz, we had observed western chickadees attacking and capturing several monarchs in the clusters.

Two other patterns of apparent bird predation occurred extensively along a logging cut that bordered one side of Site Alpha. We found numerous individual wings littering the forest floor and also saw many maimed, but still living, butterflies—some with one or more wings missing; others lacking their abdomens. One of the latter, in fact, fell out of the sky directly in front of me. I had noticed similar apparent predation in January and February 1974 at Santa Cruz and Montaña de Oro State Park.

Whether wild birds eat monarch butterflies was hotly debated earlier in this century. There is now no doubt that they do, and this raises the interesting question of how they cope with butterflies that contain emetic doses of cardiac glycosides obtained from milkweeds. My long-term assistant Susan Glazier and I have experimented with blue jays at Amherst College and have found that these birds learn to taste-discriminate the poisonous from the nonpoisonous monarchs and eat only the latter. It is tempting to hypothesize that the wild birds at Site Alpha and Santa Cruz were doing this, too, and the number of partly eaten butterflies on the ground would tend to support the hypothesis.

Over-all, natural mortality seemed to be low at Site Alpha. Upslope from the colony, however, dead butterflies littered the ground to such an extent that an odor of decomposition was strongly evident. This did not seem natural, and I wondered what had



caused it. Our guide provided the answer. On our third visit to the colony he brought a bag of salt, which he used as bait to lead cattle to the butterflies. Having previously shown us the effects of a small fire, he now shook the monarchs off several of the smaller trees. Because of the cold, the monarchs flapped helplessly on the ground, and the cattle ate them by the thousands and trampled countless others. Once inside the colony, the cattle bumped into smaller trees and dislodged large clusters of butterflies.

When Calvert first arrived at the site, the colony extended farther up the hill where the decomposing monarchs lay. We believe that the local herdsmen may have eradicated as much as 20 percent of the colony by smoking the butterflies out and shaking them off the trees for the cattle.

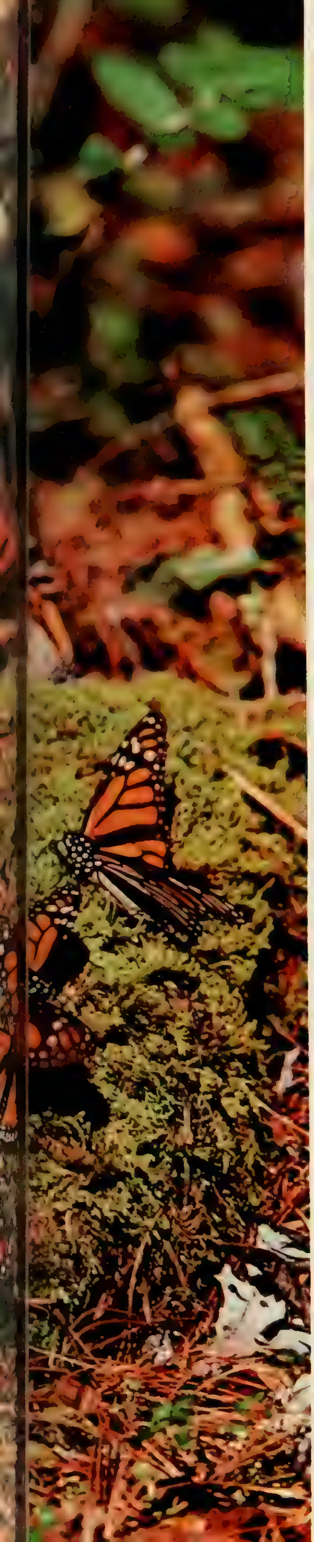
The general appearance of the majority of the monarchs at Site Alpha was of exceptionally high quality compared with butterflies from several overwintering sites in California that I have examined. Few butterflies were tattered, and the abdomens of most appeared robust, indicative of a healthy physiological state. In examining a number of collected specimens, I noticed a very high body moisture content; also that the gut was frequently filled with a watery fluid. Because of previous observations in California, where many monarchs fly out of the overwintering colonies on warm days and feed at flowers, my initial thought was that this was nectar.

We had hypothesized that the availability of nectar might well be an important factor in determining the location of overwintering sites in Mexico. Thus, one of our objectives at Site Alpha was to record the available nectar sources and the extent to which the butterflies utilize them. Several species of herbaceous plants were in flower, and we found monarchs nectaring on *Lupinus, Senecio, Stevia,* and *Bidens.* This is a montane coniferous community, however, and the flowers that normally occur here proved to be vastly outnumbered by the monarchs. Moreover, most of these plants were growing in open areas cleared by recent lumbering, and it soon became obvious that they could provide but a negligible amount of nectar for the butterflies.

On the second clear day at Site Alpha we determined the source of the monarchs' high moisture content. The butterflies appeared to be flying downhill along a draw on one side of the colony, so we followed them. A number of spring sites became evident, and wherever the sun shone upon moist areas, hundreds of butterflies were drinking. Still farther down, the draw intersected a creek where clouds of butterflies were flying about. Along the creek's edge and on rocks in its midst, thousands of monarchs were imbibing water.

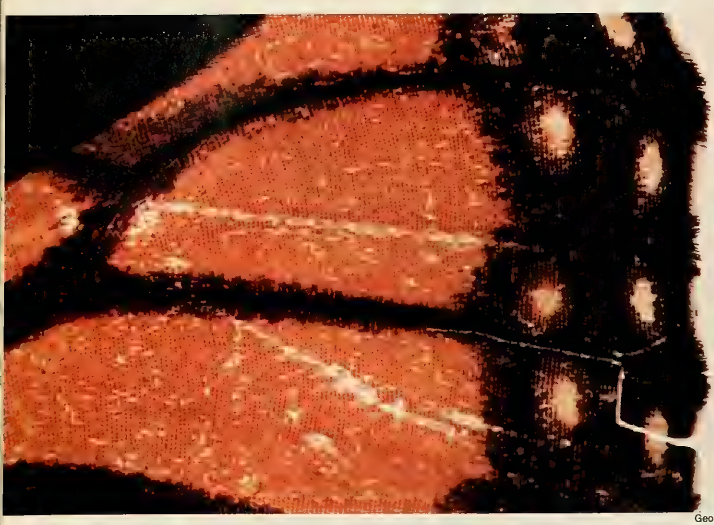
Virtually all of these drinking butterflies were simultaneously basking. Since the shade temperature (56°) was below the critical flight temperature (59° to 61°), I reasoned that they were thermoregulating to assure their ability to escape from sudden shading, should it occur either because of clouds or the shifting angle of the sun. Late in the afternoon, observations on the hillside above the colony supported this hypothesis. At about 4:30 P.M., masses of monarchs passed eastward overhead and then veered to the north, back toward the clusters in the center of the colony.

During this return I watched the butterflies against the blue sky for about twenty minutes and noticed a peculiar pulsing in their numbers as they passed by. This, together with a definite patterning of their flight, suggested the ordered movement that one often sees in schooling fish. It seems likely that these oriented mass movements are based on some kind of an interindividual spacing mechanism. This could be visual, but it might also involve the following of aerial pheromone trails produced by the flying butterflies.



Butterflies at Site Alpha drink water from wet moss on the forest floor. A high body-moisture content is important to prevent desiccation. While drinking, the monarchs also bask, insuring that they will be warm enough to make the return flight to their clusters as evening and lower temperatures approach or when clouds shade the sun.

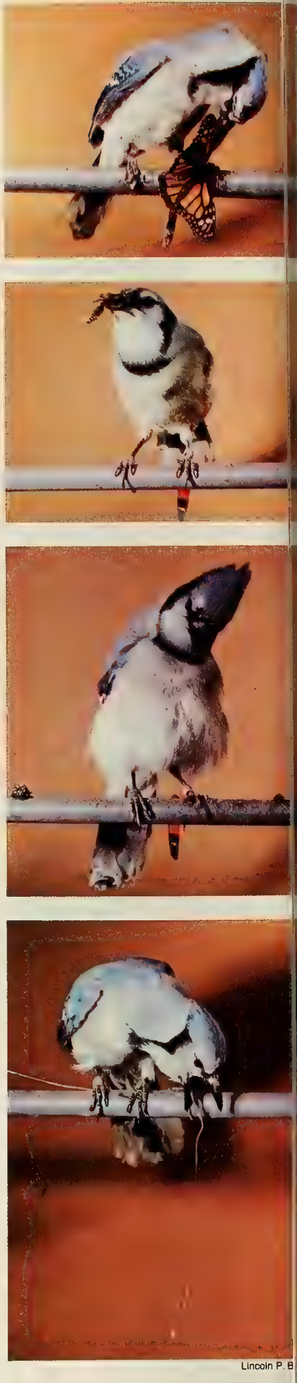
George D. Lepp



George D Lepp

The migration of the monarchs, which culminates in the overwintering colonies, is controlled by seasonal changes. As fall approaches, the last generation of monarchs produced across the North American continent is subjected to decreasing day lengths and lowering temperatures. In a series of experimental studies, zoologists William Herman and John Barker of the University of Minnesota have found that these two factors in combination trigger the neuroendocrine system of the monarch to produce a juvenile hormone that represses gonadal maturation in adults. Although details of the control mechanism are not well understood, it is clear that monarchs of the fall generation are physiologically and behaviorally distinct from those of the summer generations in ways that make their southward migration possible. These differences include the repression of egg and sperm development, a nearly complete quelling of courtship and mating activities, a loss of oviposition response to milkweeds, the development of social nectaring assemblages, and the development of late afternoon aggregation behavior that results in temporary nocturnal cluster formation. As these behaviors emerge, they combine with a tendency for the butterflies to fly generally southward, and by mid-September the mass migration is under way.

The beak mark of an avian predator is clearly visible on a monarch wing, above. Birds feed on monarchs because there is a palatability spectrum in these butterflies. How palatable an individual is depends on the species of milkweed it fed on as a caterpillar. Some milkweeds carry no toxins, others are highly poisonous. This monarch probably escaped because the bird had learned to taste unpalatable butterflies from a previous experience and quickly released its catch. In a controlled experiment, sequence right, a bluejay with no experience with monarchs is fed a butterfly that was reared on a toxic milkweed. Shortly after ingesting its meal, the bluejay began to show signs of being uncomfortable. Vomiting spells followed. This bird thereafter refused to touch any monarchs that it was offered. In the wild, some birds apparently feed on monarchs until they ingest a poisonous one. Remembering the taste of the cardiac glycosides, the birds then avoid monarchs or immediately release poisonous individuals. Because some birds will attack them, monarchs are sensitive to their presence. At far right, a cluster of overwintering monarchs in California explodes into flight as birds approach.



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George D. Lepp

Some of the butterflies at Site Alpha may fly in from the northernmost edges of their range, from northern Maine or Alberta, Canada, for example, a distance of at least 2,400 miles. If we assume that the mean distance flown by a monarch to Site Alpha is 1,500 miles and that the mean distance of the northward spring flight is another 1,000 miles, then the average Site Alpha monarch will have flown about 2,500 miles over its life-span. Now that we are certain of the massive overwintering in Mexico, this feat assumes awesome proportions.

We do not have much information on the return spring flight, but Urquhart and others before him have argued, probably correctly, that some may live on and disperse their eggs throughout the spring, thus surviving perhaps as long as nine months.

How can a butterfly, which weighs little more than half a gram (about one-fiftieth of an ounce) fuel its southward migration, survive several months with no significant access to nectar, and then perform the northward migration? Part of the answer is the energy obtained from the milkweed leaves eaten during the larval stage. This is conserved thoughout metamorphosis into the adult butterfly where it is stored in the cells of an extensive abdominal organ known as the fat body. Fall migrants do have a high fat content, and in our earlier analyses of cardiac glycosides we noted that the abdomens of many migrating and overwintering monarchs were virtual butterballs. A previous study determined that, on the average, fat made up 34 percent of their dry weight.

Biologist L. A. Schroeder has reported that monarch larvae can convert as much as 81 percent of the carbohydrate present in milkweed leaves into lipids (fats). If we assume that a similar biosynthetic transformation can take place in the adults, nectaring aggregations during the fall flight may well be refueling stops of major importance to the successful overwintering in Mexico. This speculation is consistent with the results of a dissection sample of 111 females we obtained at Site Alpha. Seventy-five percent not only had well-developed fat bodies but also contained moderate to extensive amounts of free lipids, which oozed out as yellowish droplets when dissected under water. It would appear, then, that the fall migrants are well served by the great numbers of fall flower composites that occur between the Atlantic coast and the Rocky Mountains.

By dissecting the abdomen of a female under a microscope, it is possible to examine the ovaries and determine the extent of egg maturation. In our sample of 111 females, we found no indication of mature or maturing eggs. This sample also enabled us to determine the extent of sexual activity. We suspected that it was minimal because during our entire stay I observed less than a dozen mating pairs. In butterflies, mating results in the secretion of a distinctive spermatophore (a small sac of sperm) inside of a specialized female organ known as the bursa copulatrix. As the sperm are used up, the spermatophore collapses, but it has a neck that remains intact. It is therefore possible to determine the number of times each female has mated. We found that 85 percent of the 111 females were virgin, 11 percent had mated once, and 2 percent each had mated two and three times.

The lack of both egg development and mating activity indicated that the overwintering colony at Site Alpha was largely in a state of reproductive diapause at the end of the third week in January. The conclusion seems inescapable: reproductive diapause is an adaptation that results in the suspension of heavy, energy-demanding activities, thereby greatly increasing the chances of surviving the winter and executing a successful northward migration in the subsequent spring.

Experiments by Herman and Barker have demonstrated that egg development in the monarch is minimal to absent at day lengths of less than 11 to 12 hours and temperatures of less than 68°. Site Alpha is at approximately 20° north latitude, where on December 22 (the winter solstice) the day length is 10 hours and 48 minutes. At this latitude, the day length increases by 48 seconds per day, so that by February 1 it would be about 11.3 hours, with the stage set for mating to be triggered by the seasonally rising temperature. Thus, at the time of our visit to the colony, it is likely that the monarchs were primed for reproduction, as far as day length w
concerned, but were repressed by th
seasonally normal low temperature
which reached a maximum of 60°.

The dual-control mechanism
day length and temperature seem
ideally suited to promote the repr
ductive success of the overwinterin
monarchs. Since oogenesis occu
slowly at low temperatures and do
not peak until 82°, the mated female
are free to leave the colony and m
grate northward, initially unencum
bered with large numbers of eggs, b
with an increasing rate of egg matur
tion as both seasonal temperature an
day length increase.

It is unlikely that overwintering
the monarch butterfly in Mexico is
geographically restricted as it no
seems. I predict that, as is true in Ca
ifornia, numerous Mexican overwin
tering colonies will be discovered
locations having ecological charac
teristics similar to those of Sit
Alpha. The principal reason for thi
contention is that roosting in a ver
limited area would make the specie
highly vulnerable to fire. Not onl
does the overwintering occur durin
the dry season, but this area is in th
trans-Mexico volcanic belt. Past vo
canic activity must have set man
fires, and from our observations,
large-scale fire could easily decimat
an entire colony.

I concur with the original discov
erers' desire that the precise locatio
of Site Alpha not be made public unt
steps have been taken to protect it
This overwintering colony is ce
tainly a prime example of one of th
most spectacular natural phenomen
in the world. Unfortunately, as is tru
of many important biological areas
Site Alpha is threatened by lumberin
and cattle. A coordinated interna
tional effort should be mounted a
soon as possible to protect this ex
traordinary site from what could b
inevitable destruction in the not to
distant future. □

Monarchs in clusters will sprea
and turn their wings to fac
sunlight. On cloudy days th
butterflies remain dorman
thereby conserving their energ

Geor

The Alligator Revealed

by Leslie D. Garrick and Jeffrey W. Lang

All an alligator wants is to bellow and head slap, engage in leisurely sex, and have a protective mother

Two crocodilians live within the continental United States. The American crocodile (*Crocodylus acutus*), a widespread tropical New World species, has been reduced to about 200 individuals that inhabit some of the Florida Keys, Florida Bay, and areas in Everglades National Park. This species is threatened by the continuing loss of its coastal mangrove habitat and by human-caused mortality from automobiles on local roads and destruction of nests. The other species, the American alligator (*Alligator mississippiensis*), is endemic to ten southern states from Texas to North Carolina. Its fortunes have fluctuated in the last 200 years.

Historically, alligators were either treated as vermin or exploited for their economic value. Young alligators were killed, stuffed, and sold as tourist curios, while shoes and handbags were manufactured in large quantities from the hides of adults. Sharp downturns in alligator numbers were noted by the turn of the century. During the next five decades the American alligator population decreased so dramatically that, in the late 1950s and early 1960s, some states passed protective legislation. In 1967 the American alligator was listed as an endangered species. Under state and federal protection the alligator began a slow but noticeable recovery in some areas. By 1972 the state of Louisiana, a front-runner in alligator research, management, a commerce, decided that the spec had recovered its numbers su ciently in three parishes (counties) permit annual controlled hunting early fall of several thousand alli tors for their hides.

As of February 1977, the alliga was reclassified as "threatene throughout most of its range. This galizes both the killing of alligat "in defense of human life" and sale of hides obtained in this mann The changes in federal regulati have been justified by census data c lected by game commissioners in affected states. Although attem have been made to standardize c susing among states, the danger that the loosely collected figures m be overestimates. Florida, for ample, claims to be overrun wit

Peter B Kaplan

alf-million alligators and is wamped with complaints from resi- ents. In order to alleviate the pres- ure on harried Game and Fresh Vater Fish Commission officers in he northern part of the state, Flor- la, with federal approval, will li- ense hunters to shoot these "nui- ance" alligators and to sell their ides with state cooperation. The roblem is that humans have moved nto alligator habitat, resulting in reater alligator–human contact.

Fortunately, the alligator's plight timulated a serious research effort uring the last two decades. Initially, nanagement goals, directed pri- narily toward understanding alliga- or movements, feeding patterns, and eproduction, predominated. In con- ast, our studies deal with alligator ocial life, and we have concentrated on systematically describing their social behaviors and organization. Most of our research took place at an alligator farm in south-central Florida where thirty-five adult alligators inhabit a medium-sized lake.

Biological studies of wild alligators in the Louisiana coastal marshes have determined what parts of a water body alligators use and when. By following adult alligators fitted with radio transmitters, biologists of the Louisiana Wildlife and Fisheries Commission found that adult males prefer artificial canals and other deepwater open channels year-round, and that females prefer open water during April and May, the courtship-mating period. After that, they stay near their nests and den sites. The most significant finding to come out of this work is that alligators form small breeding groups in open water during the spring.

Bellowing, usually an early-morning activity, is the most obvious signal of courtship and mating. We heard these booming roars in chorus nearly every morning until the middle of June. Apparently, bellowing attracts both sexes to a breeding group by advertising the location of potential mates. Only males were thought to bellow, but we found that females also do so, their roars often attracting courting males. However, when males approach other males, fights frequently result.

Head slapping is another display that we were able to study. In this display, an alligator slams its head into the water, creating a splash that can be heard at a distance of 200 yards above water, and probably much far-

Robert C Hermes, Photo Researchers

Males and females take turns riding on each other's backs as part of their precopulatory ritual. Blowing bubbles and geysers of water through their nostrils is also a part of a courtship that may last for hours. The larger males establish breeding territories and mate with numerous females.

ther underwater. Alligators head slap from within their territories, and responses to this signal by other individuals are very similar to those during bellowing. These two displays are the most obvious of the eighteen cataloged communication signals in the alligator repertoire (including six distinct vocalizations) that function to bind individuals into a social unit.

Now, for the first time, we can sketch the framework of alligator social structure. Upon arrival at the breeding area the males fight and the victors establish territories. We watched as the largest, most aggressive male won all of his battles and emerged socially dominant. He defended a large territory in the lake and had priority access to females for mating. Several subdominant males were excluded from his territory and occupied smaller adjacent areas. The top male also interrupted the subdominants during their courtship with females. A system of mutual advertising attracted the nonterritorial females to the dominant male and to other males. The females are polygamous and move freely from one male to another, but the dominant male probably mates more than the subdominant males.

Once a potential mate is attracted, courtship begins with greeting behaviors: the male and female touch and rub snouts, rub heads, and emit coughing sounds. At this point, the female may refuse further attention from the male by emitting a short, throaty bellow, then swimming off.

Following the short greeting, the pair begin to circle one another, ride on each other's backs, and submerge and blow bubbles. These behaviors shift about within the courtship sequence, and the pair can break off at any time.

Copulation takes place in shallow water. The male mounts his mate's back and after intertwining his tail with the female's, he lists to one side so that her cloacal vent is accessible to his penis. The entire act lasts only a few minutes.

Courtship activity lasts for six weeks, suggesting that sustained reciprocal stimulation is necessary for coordinated mating. The most intense courting and mating precedes nesting by about one month and probably coincides with ovulation. Here may be an example of how behavior a
physiology are integrated over a lo
courtship season to determine t
timing of fertilization. In any eve
a courtship period lasting that lon
even though it does involve a shifti
of partners, can be described as l
surely. From our vantage point it al
was noticeably playful.

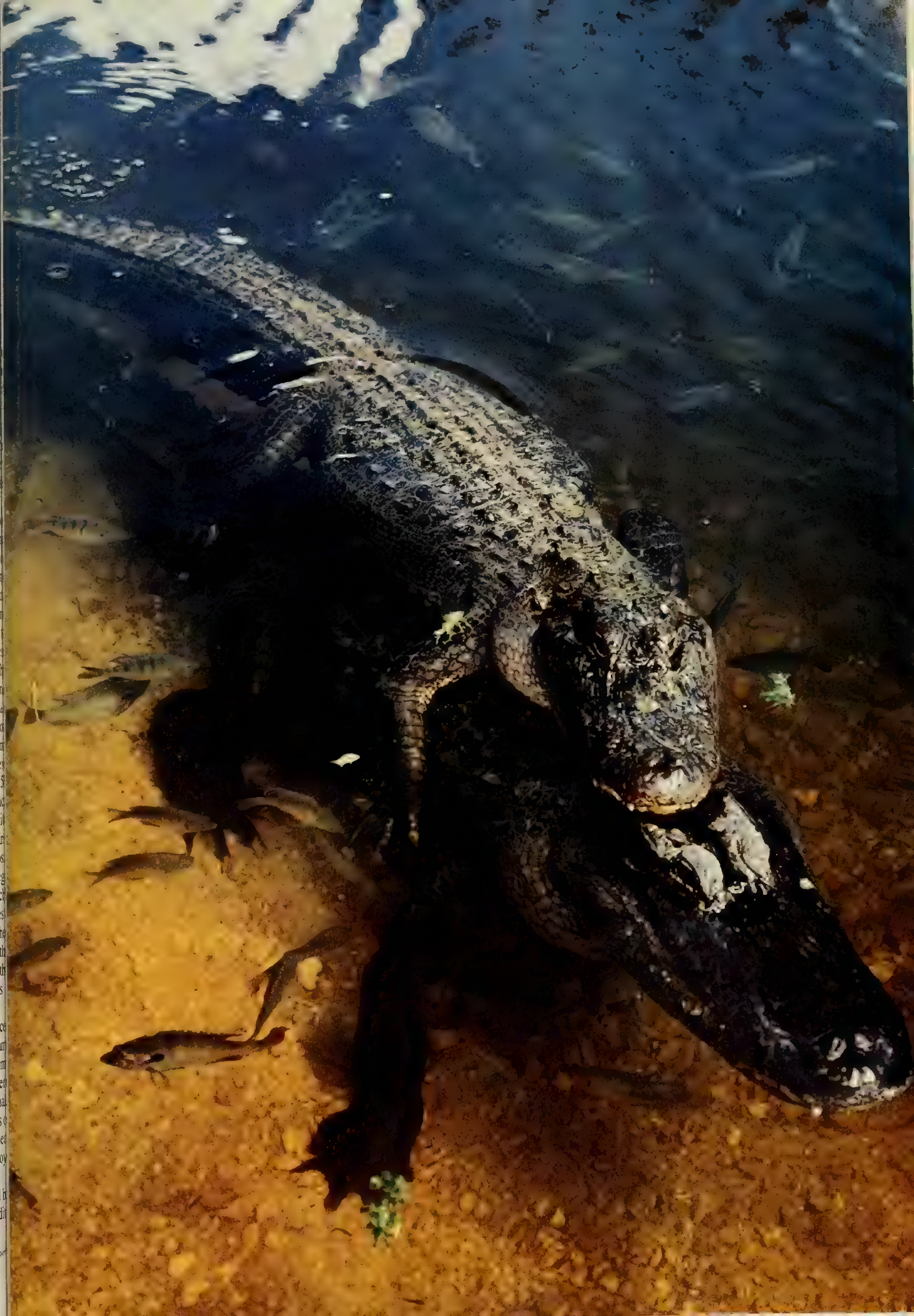
An alligator nest is composed
locally available vegetation a
earth. In early June we saw femal
crawl out of the water at night a
begin to shape, rework, and conditi
the nesting material into a mou
about three feet in height and five
six feet across at the base, a proce
that took a week. For most of t
construction they use both hi
limbs and forelimbs. The last det
prior to egg laying is the formati
of a conical egg chamber, extendi
about a foot or more below the ape

A female lays between 20 and
eggs, one every 45 seconds. As ea
egg leaves her body, she meets it w
the underside of her hind limb, fi
breaking the egg's fall and then po
tioning it in the nest. After the last e
is deposited, she covers the clutc
with amazing control she grasps ne
ing material with the claws of h
hind limbs and drops it on top of t
eggs. Once the eggs are covered, t
female reshapes the nest and packs
by crawling across it.

Nests usually are built in plac
above the high-water mark that su
mer rains will bring. Even so, sor
nests are flooded during seve
storms. Release of water from can
into former parts of the Everglades
southern Florida during the rainy se
son regularly inundates and destro
many alligator nests.

Hatching success is determined
proper temperature and humidi

D. Hughes; Bruce Cole



Leslie D. Garrick

Defending her vegetation- and earth-packed nest, left, a female will charge potential egg predato such as black bears and raccoons, and humans who ventu too close. Having worked its way out of an egg with the use of an egg tooth, a hatchling, below, wil be assisted to nearby water by its mother. Another hatchling, facin page, rests on its mother's back, basking and snapping at insects.

conditions in the nest, maternal protection against nest predators, and parental assistance at hatching. Temperatures within the egg chamber vary between 79° and 92° F during the sixty- to seventy-day incubation period. Moisture content in the nest is affected by rainfall and groundwater.

Raccoons and black bears are major predators of alligator eggs. Other studies have demonstrated that female alligators do guard and defend their nests against predators. From radio tracking studies and other observations, we know that females remain near the nest after laying. We often sighted females resting quietly at the edge of the lake near their nests; as we approached they lifted their heads and tails slightly out of the water. If we approached too close to a female, she swiftly charged toward us, driving us away from the nest.

Robert H. Potts, Jr., Photo Researchers

Just prior to hatching, the outer shell of the egg cracks and falls away, and the tiny alligator slits the tough inner membrane with its egg tooth. Even before it takes its first breath of air outside of the egg, the hatchling is capable of vocalizing a high-pitched "erk" sound. By playing the tape-recorded grunts of a day-old alligator through remote audio speakers, we demonstrated that female alligators actually respond to the vocalizations of the young. A recently completed study by Gene Meyer and Myrna Watanabe, in the Okefenokee National Wildlife Refuge in Georgia, has produced conclusive evidence that female alligators excavate the nest, carry some hatchlings to water in their jaws, and lure the remaining offspring out of their natal tombs by vocalizations. But it is also known that in areas of heavy poaching or human disturbance females do not defend nests after laying and do not liberate the young at hatching. Given the heavy mortality on hatchling alligators, such disturbance can cause a significant drain on alligator populations. Other crocodilians also defend their nests and liberate the hatchlin from the nest, emphasizing the i portance of maternal care.

Hatchling alligators, probab from the same nest, live in groups, "pods," near their mother's den si They often crawl about on t mother's head and back where th bask and snap at insects. When approached a brood the moth opened her mouth and hissed, th lunged and chased us from the are When we grasped a hatchling it em ted a loud, repetitive "distress" ye that attracted adults to the sound. experiment by Everglades Natio k biologist James Kushlan demon- ated a female's response to the tress calls. Kushlan elicited such ls by holding a newly hatched alli- or ten feet from its mother, which n rapidly crawled out of the water ward him. He then released the ung one. The female picked up the chling with the side of her mouth, reated to the water, and released it. nsporting of the young in the uth by females also has been docu- nted in American, Morelet's, and e crocodiles, and in the spectacled man.

Toward the middle of their first ar the young begin to swim alone. veral in a group we watched ap- ared to be leaders because they re followed by other individuals ring their wanderings. While imming, these leaders emit fre- ent grunts that probably help to intain contact among all the mem- s of the group and to alert others the presence of food or predators.

In spite of maternal care, young al- ators are preyed upon heavily by coons, otters, turtles, fish, and veral species of heron. The toll en by predators, when added to t taken by disease and other rces, probably reduces the origi- clutch by half within one year and 80 to 90 percent within three ars. The remaining small alligators ry likely disperse away from the ther by the second or third year, t this may be dependent upon the bitat. For example, in the Ever- des, where alligators are restricted "gator holes" during the dry sea- n, young of three successive years ve been seen near a female's den.

Crocodilians grow very rapidly, t mature late. Ranging from eight ten inches at hatching, alligators w roughly one foot during each of ir first six years, eventually reach- an adult length of six to eight feet females and ten to fourteen feet males.

A diet of insects, snails, crabs, all fish, frogs, and small mammals pports such rapid growth. Larger y such as gar and other fish, akes, birds, raccoons, muskrats, d an occasional dog are also eaten the alligator grows larger. Alliga- s are by no means finicky eaters— y will take live prey or scavenge ir meals—but they feed less frequently than might be assumed for so large an animal. Nonfood items called gastroliths (stomach stones) are sought out, ingested, and retained in the stomach. Some biologists argue that these stones function as ballast, while others are of the opinion that they aid digestion.

Retention of gastroliths enabled us to feed adult alligators a small pseudogastrolith containing a radio transmitter that encoded stomach temperature. We wanted to know how the internal body temperature of this large ectotherm (ectotherms derive body heat from the environment, rather than from internal metabolism, as do birds and mammals) fluctuated in response to daily and seasonal changes in the environment and how an alligator's behavior affected its body temperature. By simultaneously recording temperature and observing behavior, we demonstrated that an alligator can maintain its body temperature at about 89°F for

Peter B Kaplan

hours each day by basking in the sunlight on land or in the water. During the warmer months, when alligators bask infrequently and remain submerged for hours at a time, their body temperatures fluctuate by only a few degrees throughout the day.

In order to regulate their body temperatures alligators require a source of water deep enough to provide a temperature gradient and shelter from the sun, adequate vegetation on land and near the water for shade and shelter, and access to suitable land areas for basking.

Water, therefore, is the key to the alligator's survival. Within a broader wetland mosaic, this semiaquatic reptile must locate suitable water for its food, social behavior, reproduction, and heat balance. However, wetland ecosystems are disappearing so rapidly that the American alligator's survival cannot be guaranteed. For example, in 1972 biologist Jim Schortemeyer of the Florida Game and Fresh Water Fish Commission estimated that 23 percent of good alligator habitat was lost in the development of six south Florida counties.

A new life-history portrait of the American alligator is emerging, one that could save its existence. Alligators can be characterized as lacking predators (except humans) as adults, as suffering their major mortality prior to three or four years of age, as investing much time and energy in maternal care, as seasonal breeders possessing an intricate social organization and sophisticated communicatory behaviors, and as being long-lived in the wild. This is a very stable life-history pattern, one in which the alligator exploits a particular set of predictable environmental resources. For example, some female alligators show fidelity to nest sites year after year.

We have suggested how human alteration of the environment can disturb the alligator's reproductive behavior and ecology. Such human disturbance as the flooding of nests is obviously detrimental. A less obvious but equally important human impact may also soon occur. Killing of large males in the Louisiana and Florida hunting programs should be avoided because removal of such individuals might disrupt the alligators' male-dominated social structure during breeding and deprive the pop
tion of a potentially important gen
contribution.

Many important questions al
the relationship between alligator
havior and ecology remain to be
swered. One of these is whether h
tat differences generate difference
social structure; that is, do alliga
living in lakes or rivers have a
ferent social structure from those
ing in marshes. Despite gaps in
knowledge, we now have enough
formation to enable us to formula
coherent, habitat-centered surv
plan for this ancient reptile.

Hatchling alligators float in a be
of swamp lettuce, below. At this
stage of their lives, they feed
mainly on insects, snails, frogs,
and small fish. Raccoons are ma
predators on the young reptiles.
When an alligator reaches the si
of the one at right, however, the
tables are turned and raccoons
become the prey.

R.E. Pelham; Bruce Coleman, Inc.

Peter B. K

PEPSI
Country Club

California Litter

by Bruce E. Bechtol and Jerry R. Williams

In some instances, trash-laden beaches are more attractive than clean ones

California beaches: Those words evoke visions of endless stretches of sand, warmed by perennial sunshine and frequented by bikini-clad sun worshipers and wet-suited surfers enjoying a casual life-style enhanced by an occasional game of volleyball or beach party around a blazing fire.

The intensity of beach use in southern California sustains and magnifies this image. But another facet of this paradise is the increasing human impact on those beaches. Perhaps the most obvious result is litter; its volume is representative of the amount of use a beach suffers. Intrigued by the dichotomy between use and abuse, we analyzed the accumulation of litter on a beach in southern California over a two-year period.

Litter may well be the clearest indicator our consumer-oriented, no deposit–no return society leaves to mark its passage. Wherever Americans travel, work, and play, and frequently, even where they live, their discarded objects pile up in an incredible variety of shapes, sizes, and materials. Beach litter is a potpourri of refuse—from newspapers and plastic eating utensils to disposable diapers and a myriad of other commonplace and exotic items haphazardly sorted and redistributed by the sea.

The scenic Pacific Coast Highway clings tenuously to the steep, rocky cliffs of California. Occasionally, the roadway descends to sea level and skirts beaches built up by sea currents. The little ribbon of sandy beach that we observed stretches for about 300 yards along one of the coastal indentations, clasped to a sharp curve in this winding road just north of Malibu Beach. No signs warn visitors away from this small beach. There are no day use or parking fees, no rangers or lifeguards. Overnight camping is not discouraged, fires are not restricted, and animals can run free. This is one of those rapidly disappearing niches in southern California—a totally unsupervised and unmaintained recreational site on a segment of coastline that has somehow escaped development by commercial interests or government agencies.

Although much of the coastline south of this area is either publicly owned and maintained or fenced off by private landowners, this beach seems to be nobody's concern. People seek it out to be free of any form of restriction on their activities. To insure that we did not interfere, we simply watched and, as unobtrusively as possible, collected litter.

Every two months over a two-year period, we picked up, counted, and disposed of all beverage containers in the area, but its over-all appearance remained much the same. We used the bottles and cans we retrieved as representative of all litter and left other trash to accumulate at its usual rate. During our study, we did not disturb the activities of beach users. In our conversations with many of them, we found that they perceived the beach as we did, as a heavily littered but unregulated recreational site. That it was unregulated was the beach's greatest attraction and, at the same time, the source of its dismal appearance.

Beaches come and go with the seasons, reaching their maximum development by summer when human use and litter accumulations attain their highest levels. Between Memorial Day and Labor Day, the beaches are everybody's playground as swimmers, sunbathers, people watchers, fishermen, and others crowd them. By summer's end, the refuse of the previous months is quite evident. On the beach we studied, such lightweight items as paper cups, plates, napkins, food wrappers, and bags lined the base of the sea cliffs. Piles of refuse filled gullies and crevices, deposited there by people in halfhearted attempts to remove their trash. Remnants of fire pits, containing partially burned logs and garbage and surrounded by empty food and beverage containers, dotted the beach—mute testimony to the summer's activities.

The winter beach is for hardy souls. Beachcombers, strollers, dog walkers, and fishermen are most common during this season and human pressure on the beach is minimal. But

Unregulated beaches invite crowds principally because users are not restricted in their activities. Unfortunately, the frequent result is an accumulation of litter.

Jo M. Kitchen

even during the winter, the volume of discarded debris is sizable. As winds and waves scour the beach, much of the summer's trash is washed away. Shifting sands bury what is left, but this frequently reappears later as contemporary kitchen middens or "buried treasure." So long as the natural rhythm of the seasons is maintained, the seacoast will manage to purge itself of much of people's careless activity. Out of sight, however, is not always out of mind . . . everything has to go somewhere and the litter eroded from one location is usually deposited in another.

The natural cycle of seasonal beach change and human use is characteristic of almost all beaches, but human pressures are particularly noticeable on the coastal zone adjacent to large urban populations, such as those in southern California. On this particular beach, we were able to document a remarkable consistency in the volume of beverage cans and bottles thrown away during the same months each year. We could thus establish a discernible pattern of littering. Litter accumulation peaked in late summer when we collected more than 1,400 assorted beverage containers. The volume of litter as indicated by beverage containers declined in the winter months to fewer than 200 cans and bottles. By compiling the kinds of beverages and the brands, we gained insights into the nature of the people who frequented the area.

As might be expected, young people were the predominant users of the beach. We usually saw children and adolescents either with parents or in church and youth organizations. These groups camped for two or three days or used the beach for cookouts and picnics. On public beaches, some of these activities are prohibited and, where allowed, fees are required and strict supervision maintained.

On one occasion we tried to discourage a busload of cub scouts from unrolling their sleeping bags amid all the broken glass and debris. We suggested to the adults in charge that there would be less likelihood of cut feet if they camped at a nearby state park. Their reply was that there was a fee for using state facilities, while this one was free. They were aware of the hazards, having camped here before, but tolerated them in order to reduce their expenses.

We noticed that young people clearly demonstrated their impact through the number of soft-drink containers they left on the beach. These bottles and cans surpassed all other containers in total number and fluctuated markedly from season to season. After the end of each summer we collected more than 800 such containers. During the latter part of each winter, however, we found fewer than 100 of them.

Young adult consumers of alcoholic beverages were second in importance as contributors to the voluminous accumulations of trash. Beer drinkers were much in evidence during the summer. Of the more than thirty-five brands we found, Budweiser and Coors accounted for no less than 55 percent of the total. Beer drinkers typically congregated in groups of from two to six individuals and pursued activities ranging from sunbathing to overnight camping.

Hard liquor and wine bottles made up the smallest proportion of the litter that we recovered. Most were of inexpensive brands of wine and rum. Their numbers remained low and constant. We observed that most of the wine and hard liquor was consumed by older adults, not the prime users of this beach.

An offshoot of our survey was the knowledge that the antilittering campaigns of the past several years were obviously not reaching young people. The very group that we naïvely expected to be most concerned about the environment turned out to be the chief litterers at this beach.

Although America's population is expanding, we are still an affluent society, with more leisure time, money, and mobility than we have ever had. One result of this generally fortuitous situation is increased pressure on recreational resources. In order to get the maximum use out of existing resources and to accommodate e
larger numbers of people, our sc
ety has moved increasingly tow
computer-arranged, institutionali
recreation. Obtaining a campsite i
California state park, for example,
quires making a reservation mon
in advance. This leads to additio
bureaucracy, but it also results in b
ter supervision and maintenance
facilities. Use pressures are so gr
that without some such control
quality of outdoor recreational ar
would rapidly deteriorate. Even
many Americans object to such g
ernmental regulations as an
fringement on their liberty. Giv
such attitudes, many people are
tracted to nonregulated areas. Pa
doxically, with heavy use
unsupervised areas tend to suf
abuse because no one is ultimat
accountable for them.

This open beach, which draws
wide range of people seeking esca
from the metered tempo of met
politan life, is a classic example

Many people will not use cleaner, supervised beaches because such attractions as camping, making fires, and drinking alcoholic beverages are prohibited.

at can happen to an attractive rec- tional site when nobody has the ponsibility to maintain it. There is a single litter receptacle in the vi- ity; people seem to assume that little bit of trash they leave behind l not make that much difference.

The volume of litter that accumu- es on such a small section of beach phenomenal. Over the two-year vey, we collected 6,702 beverage ntainers from this site. Other forms litter, however, also continued to rue, as evidenced by rusting cans, minum pull-tabs, rotting fruit, ken glass, half-burned garbage, other miscellaneous trash. One uld think that such an array would courage use of the beach, but this not been the case. That parents let ir children play amid all the trash, t dog owners run their animals e, and that swimmers and other ter enthusiasts frequent the beach such numbers indicates the strong raction of an unregulated beach, en one that is heavily littered. Most of the time, people were forced to clear away debris before they could establish a campsite, build a fire, or spread out a picnic lunch—but still they came. When we questioned them about their reactions to this mess, many voiced a preference for the better-maintained beaches in the vicinity, but said they were not permitted to run their dogs, build fires, or camp overnight on the cleaner, supervised beaches.

Inevitably, the people we interviewed decried the beach's deplorable condition but maintained that they always took their trash with them when they left. They also frequently volunteered to give us their empty beverage containers. In two years, however, we did not observe a single individual or group removing any garbage or picking up any litter.

One can sympathize with those who oppose greater regulation of our personal lives. But as the population grows and as living space contracts and deteriorates in quality, individual and societal options decrease. In the case of this recreational site, a minimal response to the litter problem would be the placement of trash barrels at regular intervals near the beach. Unfortunately, this in itself solves nothing since someone or some agency has to be responsible for regularly picking up and removing the accumulated trash.

This is not as simple as it sounds. California has numerous examples of overflowing roadside trash containers and scenic landscapes cluttered with debris. As this one beach vividly illustrates, litter is an endemic problem of considerable magnitude in our society. If environmental quality in recreational areas is truly desirable to us as a nation, we must make some sacrifices, individually and collectively, whether it be through taxes or restrictions on personal liberties. At the very least, more attention must be given to minimal maintenance and supervision of intensively used recreational areas. ☐

Morton Beebe, The Image Bank

Bolts from the Blue

by Richard E. Orville

Lightning continues to puzzle the experts, and the process by which thunderclouds become electrified remains uncertain

Lightning strikes the earth about eight million times every day. During the period of one year, strikes in the United States alone kill some 150 persons, cause property damage in excess of $20 million, and set an estimated 10,000 forest fires that destroy $30 million worth of marketable timber. The cost of controlling these fires is approximately $100 million, or about one-third of the nation's total annual fire-control expense. Lightning causes almost twice as many deaths as hurricanes and about the same number of fatalities and the same amount of property damage as tornadoes.

Not all lightning damage occurs on the ground. Some 60 to 70 percent of weather-related Air Force aircraft accidents are caused by lightning. Commercial airplanes are involved in lightning strikes about once in every 5,000 flying hours. In most instances, nothing untoward happens; the lightning simply flows over the outside shell of the plane, and when damage does occur, it is usually slight. But there have been several notable exceptions. A Boeing 707 was downed on December 8, 1963, near Elkton, Maryland, by lightning that ignited a gas tank. All persons aboard were killed. Those aboard a Boeing 727 in a holding pattern over Chicago's O'Hare Airport on September 26, 1964, were more fortunate but will probably never forget the experience. Their plane was struck five separate times in twenty minutes but landed safely nonetheless.

Lightning is an electrical discharge—an enormous spark. It occurs mainly in towering cumulonimbus clouds, or thunderclouds, which are characterized by strong updrafts and downdrafts with velocities commonly from about 15 to 50 kilometers per hour (10 to 30 miles per hour) but that have been known to exceed 100 kph. A thunderstorm may have a diameter of about 1 to 2 kilometers and an altitude from cloud base to cloud top of 6½ to 8 km. In the mid-latitudes, the temperature at the base of the thundercloud is usually slightly warmer than freezing, although this depends on the geographic location of the storm; storm clouds in lower latitudes have correspondingly warmer bases.

Thunderclouds have a net positive charge in their upper regions and a net negative charge in their lower regions. This separation of opposite electric charges is known as a dipole. At least a dozen theories have been proposed to account for the polarity of the thundercloud, of which three are worth noting. Apparently, several charging mechanisms can occur simultaneously in a given thundercloud with the dominant one dependent on the storm's location. The dominant mechanism in thunderstorms over mountains and in high latitudes may thus differ from that in tropical thunderstorms.

Ice particles are customarily found in the upper reaches of thunderclouds if the cloud tops are high enough. Clouds with altitudes of 7,500 to 9,000 meters (25,000 to 30,000 feet) may not exhibit lightning. But when the same clouds build up to 15,000 meters, lightning suddenly begins. Taking account of that observation, one explanation for the dipole structure of thunderclouds, proposed in pendently by researchers at the N Mexico Institute of Mining and Te nology and the University of Lond attributes it to a temperature differ tial in ice. According to this theo when two ice particles come into c tact and then separate, as in a bou ing collision, a charge will m from one ice surface to another there is a temperature difference tween the two surfaces. Laborat experiments show that the warmer the two ice surfaces is left negativ charged; the colder surface is l with an equal and opposite posit charge.

It is believed that this process c operate in two ways in a thund cloud. First, large, rough-surfac hailstones, often produced in thu derclouds, fall through the cloud a collide with smaller and smoother crystals. In the collisions, t smoother-surfaced particles sli across the protuberances of the ha stones, causing frictional heati The hailstones sustain a grea amount of heat than the smooth smaller particles. The hailstones c sequently acquire a negative char and the smaller ice particles acqu a positive charge.

Secondly, hail or snow pellets th fall through a cloud may coll supercooled water droplets—liq water whose temperature is bel freezing—which freeze on impa the resultant latent heat release kee the hail at a temperature above th of the smaller ice crystals with whi the hail is colliding. The hail cons quently receives a negative charge it continues its fall toward the base the thundercloud, while the small positively charged ice particles a carried on to the top of the cloud.

Ron L. Lai

In the Northern Hemisphere, the incidence of thunderstorms is greatest between May and September. Most storms occur in the afternoon or early evening. Florida, where this picture was taken, is the most active lightning region of the United States.

M. P. Kahl/Bruce Coleman, Inc.

nother explanation—and perhaps most popular theory today—for electric charges in thunderclouds uires only that two liquid or solid ticles undergo a bouncing colli- while in the presence of the elec- field of the cloud. Initially, the ticles are electrically neutral. The causes positive charge to migrate ne side of a particle and negative rge to migrate to the other side of same particle. When two particles ide, charge is exchanged and the ticles separate with a net charge; particle will be positively and the er negatively charged. Having ac- red a net charge, the particles then ance the cloud's electric field, sing a greater transfer of charge en the next two particles collide hin the field. This positive feed- k mechanism for the separation of itive and negative charges will tinue until lightning occurs.

third theory is independent of ether the particles are water or ice can occur in a cloud devoid of ice ticles. The atmosphere typically a positive charge near the ground. s theory proposes that the positive rge is transported by convective rents to the upper part of a cloud. negative charges in the atmo- ere around the cloud top are at- cted by the cloud's positive rge, become attached to the out- of the cloud, and are carried to ower part by downdrafts along the ud edge. Once again, intensifica- —or positive feedback—of the ctric field will continue until tning occurs.

Much controversy surrounds the preceding three theories and their applicability to thunderstorms. Nevertheless, it is well known that one or more charge-separation mechanisms produce a minimum of 20 to 30 coulombs of positive and negative charge in a thundercloud (a coulomb is the amount of charge transferred in one second by one ampere. By comparison, a 100-watt bulb uses about one coulomb per second). The mechanism also creates electric fields as high as 500,000 volts per meter and electric potentials with respect to the ground of 100 million to 1,000 million volts. When those conditions are fulfilled, lightning occurs.

The high voltage produced during thunderstorms has led to the suggestion that lightning might be harnessed to provide a useful source of energy. Unfortunately, the charge delivered to the earth's surface in a lightning flash is only about 20 coulombs, enough to operate one 100-watt bulb for just over 20 seconds. Thus, the total charge available in a single active thunderstorm would not fill the energy needs of even one household.

The charge separated by one or more of the mechanisms discussed above resides on the solid or liquid particles in the cloud. When the accumulation of charged particles produces a high enough electric field, the insulation of the air surrounding the particles breaks down and electric charge flows from particle to particle in an avalanche of discharges constituting lighting.

There are several types of lightning named according to where the discharge takes place. Among them are intracloud lightning, by far the most common type, in which the flash occurs within the thundercloud; air-discharge lightning, in which the flash occurs between the cloud and the surrounding air; and cloud-to-ground lightning, in which the discharge takes place between the cloud and the ground.

The last type is mostly unobstructed by the thundercloud and is therefore widely studied even though it represents only about 20 percent of lightning flashes. A cloud-to-ground flash is composed of one or more shorter-lived discharges known as strokes. The first stroke begins in the base of the cloud and proceeds toward the ground in regular and distinct steps of 50-meter length at intervals of 50 microseconds. Called a "stepped leader," this process, which begins as a faint luminosity, creates a downward-branching pattern. As it moves toward the ground, it also produces a pipelike channel within the cloud. Carrying an average current of a few hundred amperes—enough to run several hundred TV sets for a few milliseconds—the stepped leader propagates at a typical velocity of 150,000 meters per second, or about one two-thousandth the speed of light. Near the ground, peak currents of a few thousand amperes have been reported by a research team at the University of Arizona. The stepping process deposits approximately 5 coulombs of charge on the channel, inducing an opposite charge on the ground and increasing the electric field between the leader and the point of impact.

As the faintly luminous leader comes within about 50 meters of the surface of the ground, an upward discharge jumps from the target object to meet it. At the moment of junction, the cloud is short-circuited to the ground and a brilliantly luminous, upward return stroke of high current occurs. Because the return stroke is much brighter than the preceding leader, its intense light is typically what we first see as lightning. Stepped leaders that have not reached the ground become the branches of the return stroke, and charge on these branches flows into the lightning channel.

The 5 coulombs of charge deposited on the channel by the initial stepped leader flow to the ground in a few hundred microseconds to produce peak currents on the order of 30,000 amperes but which may exceed 200,000 amperes. Studies of the rapidly changing electromagnetic field made at the University of Florida indicate that these peak currents are reached within 1 to 3 microseconds of the initiation of the return stroke. Peak lightning temperatures measured by the author in the channel were observed to be about 30,000°K, or five times hotter than the surface of the sun.

As the charge streams toward the ground, the luminous return stroke moves upward toward the cloud base

avored site for the study of htning is Mount San Salvatore, ar Lugano, Switzerland. trumented towers on the untain have recorded more than) strikes in a single year. e discharge in the top otograph is cloud-to-ground htning, while that in the tom picture is "triggered" htning, which begins on the und and moves upward vard the thundercloud.

Orville

at speeds of about 100 million meters per second, approximately one-tenth to one-half the speed of light. In the rapid passage from ground to cloud, the luminous return stroke pauses at points where the branches join the channel, and the channel brightens as charge from the branch flows into it. The stroke then continues its upward motion, reaching the cloud base in about 70 microseconds to complete a return trip that took the stepped leader 20 milliseconds on its downward journey.

With the completion of one return stroke, the flash may be over. On the other hand, if there are subsequent strokes, about 30 to 50 milliseconds will pass before a dart of light perhaps 50 meters long, called a dart leader, moves down the channel of the return stroke. Carrying a current of 1,000 amperes at a speed of 2 million meters per second, the dart leader will once again short-circuit the cloud to the ground and a second return stroke will occur. This sequence of leaders and return strokes usually takes place three to four times within a given flash but has been recorded a maximum of twenty-six times in a flash that lasted for two seconds.

The tapping of electric charge by subsequent strokes in a flash was once thought to be initiated in vertically aligned charge centers located higher and higher in the thundercloud. However, studies at the New Mexico Institute of Mining and Technology and Rice University in Houston indicate that charge centers in multistroke flashes tend to be aligned horizontally. Furthermore, research on thunder has produced maps of the lightning channel within the thundercloud that show it to be horizontal. These findings are significant in suggesting that a mixture of ice and supercooled water particles is probably present in the charged regions of the thundercloud. Higher elevations would be characterized by the dominant presence of ice, the lower regions by the dominant presence of water. Perhaps the mixture of ice and water is a prerequisite for the build up of the charge centers in these clouds.

Cloud-to-ground discharges are not the only kind of lightning that involves the ground. Studies carried out at New York City's Empire State Building in the late 1930s revealed that lightning sometimes begins on the ground and moves upward toward the cloud. A detailed investigation of such discharges, known as "triggered lightning" because they occur only in the presence of human-made objects, has recently been completed at the Mount San Salvatore Lightning Observatory, near Lugano, Switzerland. The 70-meter towers above Lake Lugano are involved in more than 100 flashes each year, more than 80 percent of which are triggered lightning. The remainder are the normal cloud-to-ground discharges.

Triggered lightning begins with a stepped leader that flows from the tower top upward toward the thundercloud. On reaching the cloud base, an increase in the channel luminosity occurs but no return stroke follows. If there is a subsequent lightning stroke, it is initiated by a dart leader that begins in the cloud and moves down the old channel to the tower. A normal dart-leader/return-stroke sequence then takes place in all subsequent strokes. A curious feature of these flashes is that they are occasionally the only ones that occur during a "thunderstorm" over Mount San Salvatore, which suggests that in the absence of the towers on the mountain, there might not have been any lightning at all.

Intracloud lightning, the most frequent kind of flash, begins with a leader that moves between charge centers in one direction only and produces a more or less continuous, but flickering, luminosity for approximately 0.2 second. During this time, the amount of charge transferred is probably similar to the amount involved in a ground discharge. Studies of strikes to instrumented aircraft that fly through thunderclouds indicate peak currents of only a few thousand amperes, an order of magnitude less than the currents in cloud-to-ground return strokes. Intracloud discharges illuminate a cloud without the lightning channel being visible. The cloud takes on the brief appearance of a white sheet, hence this type of discharge is popularly referred to as sheet lightning.

Flashes that take place between a cloud and the surrounding air are called air discharges. These occur when a flash moving toward the ground fails to reach it or when intracloud discharges extend into the surrounding a cloud.

Other types of lightning with s familiar names as forked, str heat, hot, cold, ribbon, and bead all be explained in terms of clouc ground discharges.

Forked lightning refers to a ma branched cloud-to-ground light flash. A discharge without branc is called streak lightning.

Heat lightning is a distant cloud ground or intracloud discharge flashes on sultry summer evenin As a result of the great distance to discharge, a preponderance of l light is scattered from the discha and the flash is characteristically or orange like the setting sun. cause of the distance to the fl thunder is usually not heard in c junction with heat lightning.

The terms hot and cold lightn refer to those ground discharges cause forest fires and those that not. Flashes composed of stro with currents of a few hundred peres that last for at least a tent a second after their greatest inten are capable of starting forest fires are consequently called hot lightni Flashes with shorter-lived curr cause only explosive damage to t and are known as cold lightning.

Less frequent than the types lightning already discussed are bon and bead lightning, additic forms of ground discharges. I strong wind is blowing perpendic to the line of sight during a m stroke flash, the lightning char may be blown sideways and sub quent strokes will be displaced. I to the residual image on the retin the eye, the flash may resemble a bon composed of several strokes.

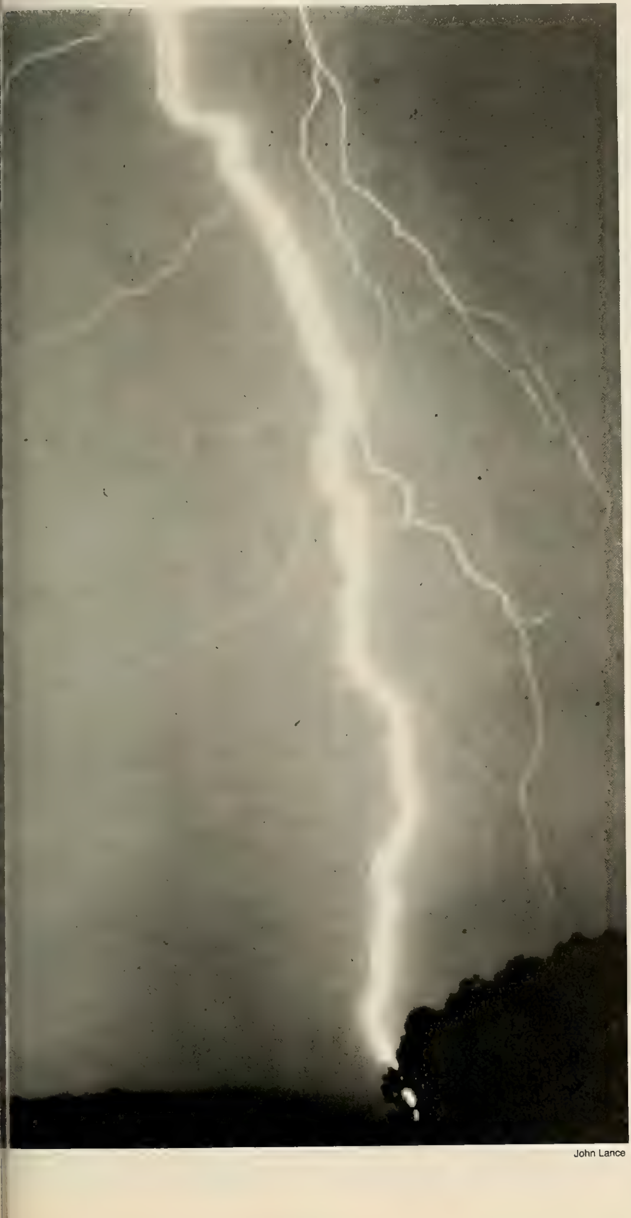
Bead lightning is even less cc mon than ribbon lightning. In type of discharge the main chan breaks into luminous sections, beads, as the light intensity of channel decays. Some sections of channel remain luminous longer t other sections either because they viewed end-on or because they h a larger diameter and therefore t longer to cool.

Ball lightning is the name given the mobile luminous spheres t have been observed during thund storms. They are often the size of orange or grapefruit, have a lifeti few seconds, and are usually red, ge, or yellow. The balls gener- move horizontally at a velocity few meters per second. Many do rise, as a sphere of gas might be cted to do. Unfortunately, there adequate theory to explain ball tning.

lmost all types of lightning discharge are followed by thunder. The powerful flow of current in a lightning flash heats the surrounding air, which expands rapidly forming a shock wave. Initially, the air expands at a rate faster than the speed of sound (1,100 feet per second) but the shock wave quickly decays to a sound wave and is then heard as thunder.

You can estimate the distance to a lightning flash by counting the seconds between seeing the flash and hearing the thunder. For every second you count, add about 300 meters (approximately 1,000 feet). For example, if it takes five seconds for the thunder to reach you, the lightning was one mile away. I am often asked if I am ever afraid of close lightning strikes when doing experiments in thunderstorms. My answer is, not if I hear the thunder. If the lightning is so close that you cannot hear the thunder, you are a part of the strike.

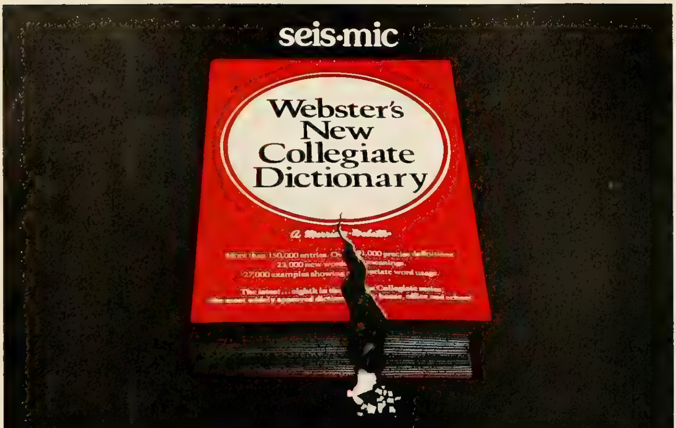
In view of the extent of the damage caused annually by lightning and of the gaps in our knowledge about it, many scientists have turned to the study of lightning and thunderstorms. Seventy investigators from more than twenty universities and government agencies are currently midway through a three-year program called the Thunderstorm Research International Program (TRIP). Based at the Kennedy Space Center in Florida, TRIP makes use of sophisticated research equipment, including radar and aircraft. Among the questions the scientists hope to answer is, Just how does a thunderstorm work? Studies by many of us in the past have been performed singly to determine the physical properties of the lightning flash. Yet prediction and control can only come after we gain an understanding of the complicated meteorological patterns of air flow and precipitation that are associated with the build up of the charged regions in thunderclouds. This requires a large, coordinated scientific effort using the latest technological advances to investigate all aspects of the thunderstorm simultaneously. In the end, we hope that our effort will bring the goal of lightning prediction, and perhaps limited control, within the realm of applied technology. ☐



John Lance

Ribbon lightning, a relatively infrequent type of discharge, is named for the effect created when strong winds blow across the point of observation and displace the successive strikes in a flash.

seis·mic



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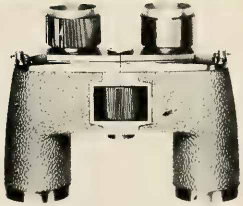

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Letters

Tobacco Row

"The Unnatural History of
bacco" (April 1977) should be n
reading for every grammar, h
school, and college student.

C. H. McKECH
Cambridge, Massachus

Erik Eckholm's article, "The
natural History of Tobacco," suf
from an imprecision uncharacteri
of your publication. Built on a pr
ise that is grossly generalized, the
ticle is a house of cards. The prem
repeatedly stated, is that the "m
cal case against tobacco" is "a
some," "airtight," "conclusiv
"growing," and "massive." S
terminology begs definition and s
stantiation. A "medical case"
more than accusations and non se
turs.

There is an essential distincti
not made in the article, betwee
hypothesis suggested by statistical
sociation and the sum of the labo
tory, clinical, and epidemiolog
evidence necessary to establish sci
tific proof. The fact is that there is
conclusive laboratory or clinical e
dence that cigarettes cause a
human diseases with which they h
been statistically related. So we
left with statistical associations.
responsible epidemiologist says t
statistical associations alone can
tablish cause and effect. The best t
such statistics can do is to sugges
hypothesis, and that's the prim
basis for the medical case agai
tobacco: a hypothesis based
statistics.

Dr. Carl Seltzer of Harvard exa
ined the statistics concerning he
disease and found some curi
anomalies. For one thing, he fou
that the attack rates of coronary he
disease (CHD) were lower for sm
ers who had stopped smoking th
they were for people who ne
smoked. Following the conventio
hypothesis, he said, it would be bet
to smoke and then stop than never
smoke at all. He rejected the noti
of course, but said the anomaly ups
any causal hypothesis.

In a paper in the *American He*
Journal (July 1975), Dr. Seltzer

ed the many questions implicitly d by the statistics and concluded: less these inconsistencies and licts in the data are satisfactorily roved or reconciled, the current thesis for cigarette smoking as a r risk factor in CHD must be amined and alternatives must be ht.''

of. Philip Burch of the Univer- of Leeds in England found the stics replete with similar anoma- on lung cancer and other dis- s. For example, among smokers ound a lower rate of Parkinson's ase. He dismissed the hypothesis smoking prevents some diseases causes others. Burch quoted the Sir Ronald Fisher, regarded as father of modern epidemiology, said that the hypothesis concern- smoking and lung cancer may prove to be "a catastrophic and spicuous howler."

his recent book *The Biology of cer: A New Approach,* Burch ed: "Those epidemiological stud- hat purport to show a causal con- ion between cigarette smoking various cancers, but particularly cancer, fail when examined crit- ly to establish the causal claim.''

rofessor Burch observed that lung cer is unquestionably overdiag- ed today. Autopsy studies have wn that lung cancer has been over- gnosed by as much as 50 percent ecent years.

r. Milton Rosenblatt in an article *ew Scientist* ("Lung Cancer and oking—The Evidence Reas- ed,'' May 9, 1974) concluded the recorded increase in lung cer can be attributed to new diag- tic techniques, including X rays, tum cytology, and biopsies.

he scientific literature contains erous articles on other possible ors in lung cancer, such as genetic disposition, viruses, and exposure umes, gases, and dust. To cite just , Dr. Theodor D. Sterling, in an cle in the *American Journal of lic Health* (February 1976), ana- ed the data and concluded that e secular trend of lung cancer in n runs counter to a smoking-lung cer hypothesis, while the secular trend of lung cancer in women just as easily supports the hypothesis that the major antecedent of lung cancer may be found in occpuational exposures rather than in smoking.''

Data from the 1975 National Cancer Institute study show that smoking patterns cannot explain the geographic distribution of lung cancer found. Dr. Joseph F. Fraumeni of NCI said: "Something else is going on.'' (*Atlas of Cancer Mortality for U.S. Counties, 1950-1969:* DHEW Publication No. [NIH] 75-780).

With questionable laboratory evidence, disputed statistics, and a number of other hypotheses, the indictment of cigarettes is hardly "airtight.'' Eckholm then asserts that ambient cigarette smoke harms nonsmokers. He offers no evidence. A research paper in the *New England Journal of Medicine* (April 17, 1975) found no evidence that ambient cigarette smoke harms normal nonsmokers. A physician who reviewed the research in the same issue concluded that the complaints might be psychogenic in origin.

Even those who have been vocal against smoking agree there is no proven harm to the nonsmoker. Dr. Ernst Wynder of The American Health Foundation said recently that cigarette smoke can be "disagreeable,'' but added, "it has no influence on the health.'' Last September, Dr. Gio Gori of the National Cancer Institute said, "If you want to remain with fact and not with fiction, there is little danger of disease to people that stay in the room, say, where people smoke.''

During the past twenty years, most of the publicly supported research on the diseases blamed on cigarettes has been started with the predetermined conviction that cigarettes would be proven guilty. This approach violates a cardinal principle of scientific investigation and usually is unproductive or worse. There still is not acceptable evidence on which to convict cigarettes.

During the same period, the tobacco industry has contributed more than $60 million for independent re-

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search on smoking and health, with no strings attached. This amount is far more than all the voluntary health agencies combined, the same agencies that indict cigarettes in their public appeals for funds.

The industry's long-standing position is that the truth will be found in the laboratory, not in polemics.

Eckholm has delivered seven pages of opinions, all on one side, without a single indication that contrary opinions exist. It is thus not surprising that he concludes by advocating the "vigorous, systematic use of all possible educational channels, advertising restrictions, prominent warnings on cigarette packages, tax disincentives, and so on."

Demurrers aside, those are subtle and, in the case of "tax disincentives," not so subtle forms of coercion to modify behavior.

Also not so subtle is Eckholm's statement that the federal government spends $50 million a year "supporting the tobacco industry." The implication is that there is a subsidy for the cigarette manufacturers, while in reality the government support program is designed to stabilize tobacco leaf production and assure fair prices to the growers. Since its establishment by the Congress, the program has cost little more, in 43 years, than what Eckholm claimed for one year. No other farm commodity price-support program has fared so well or cost the taxpayers so little. Under mandated acreage and poundage limits, it assures a good portion of America's farm families a just return on investment.

Within the past month, the Secretary of Agriculture told a House committee that ending tobacco price supports would put 600,000 to 800,000 families on the welfare rolls.

Eckholm questions the inclusion of export tobacco under Public Law 480, a program of concessional agricultural sales to needy countries. But through such trade promotion, overseas sales of this American farm product now contribute more than $1.2 billion a year to the over-all U.S. trade balance.

The economics of tobacco should by no means be equated with any alleged health effects. But a truly objective chronicle of America's first industry should, in addition to delving with open mind into the medical literature, have addressed tobacco's importance to present economic wellbeing.

Innuendos, imprecisions, and y-
potheses-stated-as-fact would se
too often these days to be the h
mark of the young journalist w
considers himself infallible. In a m
terly essay, *On Liberty,* a great wr
and thinker, John Stuart Mill, wr
"The opinion which it is attempte
suppress by authority may be t
Those who desire to suppress i
course deny its truth: but they are
infallible. They have no authorit
decide the question for all manki
and exclude every other person f
the means of judging."

None of us is infallible, and I sp
for all the tobacco industry when I
that we believe that your 400,
subscribers and countless m
readers deserve a more objective t
tise on tobacco than your respec
and usually eminently fair magaz
has given them.

HORACE R. KORNEG
President, The Tobacco Insti
Washington, D

THE AUTHOR REPLIES: As I note
my article, as far back as 1953
New England Journal of Medic
characterized the evidence link
cigarettes and lung cancer as "
strong as to be considered pr
within the everyday meaning of
word." Since then, of course,
medical case against cigarettes
grown broader and even stronger
a result of both epidemiolog
studies and laboratory experime
which have confirmed the presenc
carcinogens in tobacco smoke and
hazards of carbon monoxide po
tion.

Each of the statements in my art
about smoking's effects on healt
well documented in the medical li
ature. I made no original asserti
about smoking's threat to onesel
to others, but rather accepted
judgments of such qualified auth
ties as the World Health Organizat
Expert Committee on Smoking
Its Effects on Health (see *W*
Chronicle, August 1975), and
U.S. Public Health Service (see
Health Consequences of Smoki
1975, U.S. Department of Hea
Education, and Welfare, June 197
That Mr. Kornegay can locate a
researchers who question smokin
dangers is not surprising, but
opinions of such individuals
scarcely counterbalance the prep
derance of informed medical opini
For example, Kornegay cites Pr
Philip Burch's dramatic statemer

t does not mention the editorial that ey inspired in the *British Medical urnal* of August 21, 1976. Burch, *Journal* observed, "must be vir- ally alone . . . in asserting that the ual hypothesis [that smoking pro- tes lung cancer] is 'a catastrophic d conspicuous howler.'"

Kornegay quotes from Dr. Joseph Fruameni, Jr., and Dr. Gio B. Gori the National Cancer Institute as ough their views contradicted ne. I doubt this, however, since by incidence both of these distin- ished researchers had reviewed and entially agreed with my draft man- ripts on smoking and cancer. The tional Cancer Institute's valuable estigations of geographic varia- ns in cancer rates will likely help cover industrial carcinogens but in way contradict the evidence that oking is the principal cause of lung cer. To suggest otherwise is to tort badly the meaning of Dr. Frua- ni's statement.

For obvious ethical reasons, the t of long-term, controlled study of nans that might provide the final, mal "proof" of smoking's haz- s will never be carried out. Thus, can expect those with a financial stake in the tobacco trade to continue their efforts to obfuscate the obvious. But almost no one is fooled by the cigarette industry's blandishments anymore.

Ah, Kiwi

I look forward to Raymond Sokolov's witty and civilized articles on rare foods, and "Strange Fruits" (March 1977) was no exception. It also brought back memories of my first taste of kiwifruit. I had the good fortune to enjoy a rest leave in New Zealand during World War II. The name kiwifruit may have been adopted in New Zealand as early as 1906, but in 1944 I was introduced to the fruit as Chinese gooseberry and its taste has stayed with me through the years. I recently saw my fondly remembered Chinese gooseberry at a fruiterer's and bought one, looking forward to recapturing the taste of New Zealand after 33 years. What disappointment! Ripened in the crate is not ripened on the vine. Or has my memory played tricks with my taste buds?

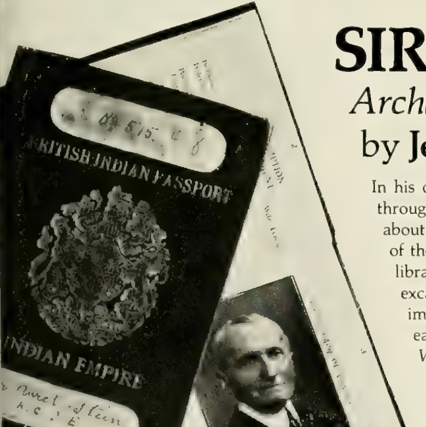
I was surprised that Sokolov did not mention the passion fruit, which I also enjoyed in New Zealand. As I remember, it was the size of an Italian plum, its hard dark rind was broken away at the top and the fruit scooped out of the rind with a demitasse spoon as one would eat a boiled egg. The small, soft seeds were covered with the flesh of the fruit much as a pomegranate, but the seeds, being small and soft, were eaten with the meat. Trusting my memory, the taste was delicate and exotic, like no fruit I have eaten before or since. Where, oh where for a vine-ripened kiwifruit or passion fruit?

PHILIP WINOGRAD
Yonkers, New York

Reading the article "Strange Fruits," by Raymond Sokolov, I was surprised to learn that kiwi isn't grown in this country. In this area there are many acres of kiwi grown, with associations for growers. A problem with the vine is the initial cost of planting, so most people have small plantings of five acres or less.

If Sokolov wants kiwi so badly, perhaps he should come here in late summer. He could gorge himself at that time.

MARY ANNE HAYRE
Marysville, California



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Lorenz Observed

KONRAD LORENZ: A BIOGRAPHY, by Alec Nisbett. *Harcourt Brace Jovanovich, $10.00; 240 pp., illus.*

Few figures in twentieth-century biology have been as controversial as Konrad Lorenz, founder of the modern discipline of ethology (the study of animal behavior) and recipient, with Nicolaas Tinbergen and Karl von Frisch, of the 1973 Nobel Prize for Physiology or Medicine. Alec Nisbett's biography makes it clear why Lorenz became involved in one controversy after another. Throughout his career Lorenz chose to focus his attention, not on trivial questions, but on the most fundamental issue of animal social life: the origin of behavior. No topic could involve more potential controversy. Among biologists it raised again the old dichotomy of "nature vs. nurture"; among nonbiologists it questioned the whole method of extrapolating from animal to human behavior. Coming down as distinctly as he did on the side of the innateness of much animal behavior, Lorenz was bound to stir more than a few hackles.

In the introduction, Nisbett explains that his purpose is "to indicate a way through the thicket of what are sometimes densely interwoven, and at others only half-related, ideas that one man has launched in a lifetime's industry. To see best how these fit together demands some understanding of the man himself, and his own personal history: my aim is to provide this in a sympathetic but critical biography." Sympathetic it is, but critical it is not.

Nisbett traces Lorenz's career from his birth and early childhood in Altenberg, Austria, through his gymnasium and medical education (M.D. from the University of Vienna in 1928), to his entrance into the field of natural history with studies of the behavior of jackdaws (1928-31), and somewhat later, careful observations of nesting behavior in the greylag goose. From there Nisbett chronicles Lorenz's work on behavior in a variety of other species (mostly fowl), which, for lack of a regular academic appointment, he carried out at his family home in Altenberg. In 1940 Lorenz received his first university assignment, as professor of psychology at Albertus University in Königsberg (now Kaliningrad). Pressed into medical service during the war,
Lorenz returned to Austria in
without a job and accepted a
pointment with the newly reo
ized Max Planck Institute (for
the Kaiser Wilhelm Institute).

Throughout this chronology a
picture of Lorenz emerges. O
one hand, he is portrayed as the
relaxed naturalist who likes no
better than to be left alone to s
countless hours peering throug
bullrushes at a family of d
watching patiently the courtshi

H. Kacher

by Garland E. Allen

or of some greylags in his gar- or reading and writing in his y at Altenberg, bothered only by occasional visit of one of the y domesticated birds that freely ned his house. This side of the appears as a good-natured, hu- ous, grandfatherly sort of nine- th-century naturalist. On the r hand, beneath this surface se- ty the picture of an energetic, ly ambitious scientific politician rges slowly, but unmistakably. cely independent and individ- stic, Lorenz chose at first to work e, supported, one gathers but is told, by his father's money. r, he relentlessly sought an aca- ic appointment, not so much for salary that might be involved, but use he felt the need of a recog- d position from which to launch popularize the then-new science imal behavior.

here can be little doubt that nz occupies an important place ne history of modern ethology. y in his life he read the older nine- th- and early twentieth-century ers on behavior and instinct ry: Herbert Spencer, Lloyd Mor- , Robert M. Yerkes, and William Dougall. Lorenz was dismayed at ack of detailed observational data which these authors had based e-scale generalizations about ians as well as animals. Lorenz been interested in natural history child, and brought to the study pecies-specific behavior the skills n exceptional observer. Among earliest observations was the phe-

rad Lorenz, out for a ll, is followed by a line of se that have imprinted him and recognize as their "mother."

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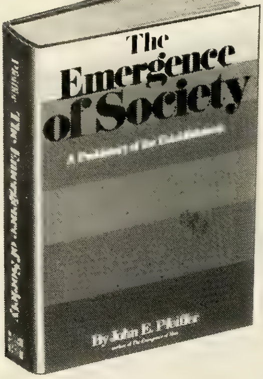

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nomenon that came to be known as "imprinting"—the attachment of young chicks or goslings to the first moving object they encounter after hatching—a process he showed to be "innate." Lorenz demonstrated that young fowl imprinted on a mechanical bird, on himself, or even on one component of his body such as his foot. Over the years, quaint pictures of Lorenz being followed by groups of young chicks or ducklings that imprinted on him have graced the pages of biology texts and popular articles.

Beyond merely observational skills, Lorenz also possesses an unusual knack for devising simple experiments to "dissect out," as he calls it, the components of behavior. In some interesting work carried out in 1937 with Nicolaas Tinbergen, who was to become his long-standing friend and colleague, Lorenz noted that if an egg was placed near the nest of a greylag goose, she would roll the egg toward the nest with a characteristic vertical bobbing and a horizontal "steadying" movement of the beak. If the egg was removed after the goose had gotten it about halfway to the nest, the animal continued to bob its bill up and down but ceased to perform the sideways steadying movements. The conclusion was simple. Egg-rolling behavior consists of two distinct and separable components: one, the bobbing vertical action, which is innate and continues whether or not the egg is still present, and two, the sideways steadying movement, which is not innate but depends for its continuance on an environmental stimulus (the presence of the egg).

From such observations and experiments, Lorenz hoped to go beyond mere description of behavior to an analysis of its "structure." He spoke of structural "units of behavior," such as bobbing and sideways beak motions, which were the smaller, discrete components of a more complex pattern called egg rolling. Moreover, these units of behavior were as real to Lorenz as anatomical structures. Lorenz believed (without any substantial evidence) that many such units were genetically determined; in fact, he sometimes spoke of "behavioral genes." He firmly held that such instinctual, genetically determined behavior had been produced by natural selection and was as much an adaptive trait of a species as anatomical or physiological traits.

For Lorenz it was not a far specula-
tive leap from such detailed beh
as egg rolling to more general be
ior patterns such as territorial de
or aggression. To him, these al
volved the same sort of innate,
grammed response as egg rol
That all species did not possess
behaviors was no more surprisi
Lorenz than the fact that all sp
do not possess feathers or bino
vision. So convinced was he o
biological nature of innate resp
that, in the case of aggression, Lo
even proposed a mechanical mod
explain how aggressive behavior
generated. According to the so-c
hydraulic model, aggressive ene
build up constantly within an
nism, much like water accumulat
a tank. If no outlet is provided
reservoir fills to overflowing, burs
its boundaries in a violent and unn
ral way. In nature, most animals
the opportunity to release their r
voir of aggressive energies const
and in relatively harmless w
Thus, small-scale acts of aggres
in animals generally lead to an av
ance of actual violence.

In humans, however, Lorenz
the aggressive energies being de
a natural outlet (he has sugge
competitive sport as one alternati
They thus build to immense pro
tions and produce violent and
deadly conflicts. In *On Aggress*
Lorenz extended this theory
wholesale explanation for the var
kinds of aggression (crime,
found in human societies. Aggres
behavior is natural; society
learn to channel this "instinct'
proper directions. The prevalenc
violence in human societies is
according to Lorenz, a result of s
conditions, for example, racial o
onomic oppression, but a result o
failure of society to provide a suit
outlet for innate aggressive energ

Within scientific circles Lore
instinct theory triggered an enorn
controversy. Among Lorenz's
lowers were a number of Euro
ethologists, most notably Nico
Tinbergen and Irenäus Eibl-Ei
feldt. Among his sharpest critics
American behavioral psycholo
J.B. Watson and B.F. Skinner,
a younger group of American eth
gists, including T.C. Schneirla
Daniel Lehrman. Lorenz's critics
only questioned the interpretatio
many behavior patterns as instinc
(which other observers found to
a large component of learning)
also severely attacked his b

ods of arguing by analogy, his
stent anthropomorphism, and
enchant for extrapolating from
r animals to human beings.
sbett's biography has done much
int a unified picture of Lorenz as
a person and as an ethologist. In
echnical language he has de-
ed most of Lorenz's scientific, as
as popular, writings in a clear
The main problem with the
lies in its largely apologetic na-
Far from being a critical biogra-
Nisbett's book bends over back-
l to rationalize many of the con-
rsial aspects of Lorenz's life.
example, whenever Lorenz
ed to be wrong about a specific
—such as his theory that the do-
tic dog originated from the
en jackal rather than from the
f—Nisbett emphasizes that
ether right or wrong . . . Lorenz
played his usual role of stimulus
thers." While in individual in-
ces such an argument may be
used too often, it says nothing
is very illuminating.
ake another case. When Lorenz
mes intolerably anthropomor-
(for example, he claims that it
erfectly reasonable to describe
bonding in turtledoves as "mar-
," even involving "love," since
behavior pattern has many overt
larities to human marriage and
), Nisbett lets the matter go with
enz's own justification that
ropomorphisms are often the best
riptions available for specific ani-
behaviors. The issue is more
ous than simply the use or nonuse
anthropomorphic terms. Given
nz's penchant for leaping from
al to human behavior, there is a
cal flaw in anthropomorphic
king. If innate animal behaviors
described in anthropomorphic
s, and then those very descrip-
s are used as the basis for arguing
similar behaviors in humans must
efore be innate, as in animals, the
ment becomes circular. *A* is de-
d in terms of *B*, and then *B* is said
the same as *A*. Given the impor-
and controversial nature of
nz's extrapolations from animal
uman behavior, failure to point
such flaws in logic provides a less-
-clear understanding of the prob-
s in trying to study innate behav-
It leaves the reader sharing
nz's view that if an analogy
nds right, it must be right.
ar more serious is Nisbett's lack
ritical approach to the social im-

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pact of Lorenz's theories and explicit espousal of Nazi ideology. Nisbett does not try to hide the fact that Lorenz had certain sympathies for the Nazi cause, or that Lorenz wrote at least one infamous paper in 1940 (''Disorders Caused by the Domestication of Species-Specific Behavior''), which was not only racist in import but was couched in Nazi terminology. In discussing this paper, Nisbett argues in the most contorted vein that Lorenz was politically naïve; that he only recognized the evils of Nazism in 1943 when he saw a group of Gypsies being carted off to a concentration camp; and that the topic of domestication of races was for Lorenz a ''purely scientific'' issue in 1940.

The length to which Nisbett will go to apologize for Lorenz is seen in his attempt to minimize the serious racist implications of the article. In his 1940 paper, Lorenz argued that in domesticated animals degenerative mutations result in the loss of innate, species-specific releaser mechanisms governing mating patterns. These mating patterns are necessary for maintaining the purity of the stock. If allowed to mate at random, most domesticated strains would soon revert to their wild-type ancestry. In humans, who have also become ''domesticated'' by their civilization, random mating would yield similar results: the loss of pure ''types.'' Under more natural conditions each human type (read, ''race'') has an ''innate esthetic mating sense''—people of ''higher types'' being naturally repulsed by the physical appearance of people of ''lower types.'' The biologically determined esthetic sense helps maintain purity of type or race. The breakdown of this system through overcivilization has resulted in racial degeneracy in Europe—only the state, by controlled breeding, can stop the decline toward degeneracy. (Lorenz made this argument less than five years after the passage of the infamous Nuremburg Laws, which made marriage between Jews and Gentiles illegal in Germany!)

Nisbett goes out of his way to downplay the racist overtones in this argument. First, he makes a huge furor over a small semantic point: Lorenz claimed that he was mistranslated by one of his American critics (Leon Eisenberg) in a highly critical paper published in *Science* in 1972. In a controversial passage of Lorenz's original, in which he describes how
superior people are esthetic
repulsed by inferior people, E
berg translates the phrase *Mens*
des anderen Geschlechtes as ''m
another race,'' whereas Lo
claims he meant ''people of the
sex.'' But fine points of etymo
are not the issue here. The ove
tone of the 1940 paper is so filled
Nazi terminology and ideology,
is so overtly racist, that to argue
the use of a single word serves
to distract the reader from the
point.

Second, Nisbett argues that Lo
is no more a racist in describing
tain human groups as ''degenera
than he is in describing the dome
goose as a degenerate ''race'' of
greylag. But elsewhere in his wri
Lorenz makes it clear that he ''
likes'' domesticated forms far m
than their wild ancestral types.
idea could be closer to the Nazi id
ogy of superiority of the No
''type,'' the progenitor from wh
all other races have degenerated.
third, Nisbett claims that Lorenz
writing his 1940 paper, was
''creating'' Nazi ideology, but
''asking for a scientific reexaminat
of ideas that had already been fi
in orthodox Nazi 'philosophy.'
evidently hoped by a little clever
nipulation to get his own ideas
cepted into Nazism.''

All of these rationalizations for
1940 paper are weakened by the t
picture of Lorenz that Nisbett him
paints. Personally, Lorenz see
always to have been a comp
miser—a sellout if one wants to
less kind. For example, when tak
his Ph.D. orals, Lorenz sensed
one of the examiners stood on the
posite side of a particular controve
from himself. Accordingly, Nisl
tells us, Lorenz gave answers
the examiner would find ''accep
ble'' even though he himself belie
differently.

More important, Lorenz was
naïve about the social and polit
implications of his theories. Nisl
shows us that Lorenz took every
portunity to draw connections
tween animal and human social
havior. In *On Aggression* and a h
of popular articles and books, Lor
repeatedly made the same ba
points, stripped of Nazi terminolo
as found in his 1940 paper. Furth
more, Lorenz did not object, exc
in a few instances, to the widespr
popularization of his ideas about
ritoriality or aggression in the jo

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nalistic writing of Robert Ardrey (*The Territorial Imperative*), Desmond Morris (*The Naked Ape*), or the team of Robin Fox and Lionel Tiger (*The Imperial Animal*). With a general world view that held that much of human behavior, and thus social worth, is innate, Lorenz helped create and maintain the ideological foundation on which the Nazis could build their myths of Aryan superiority and anti-Semitism. In the long run it matters relatively little that Lorenz wrote an explicitly Nazi paper. The damage was done, and continued to be done, through the more customary channels of strictly "scientific" literature both before and after 1940.

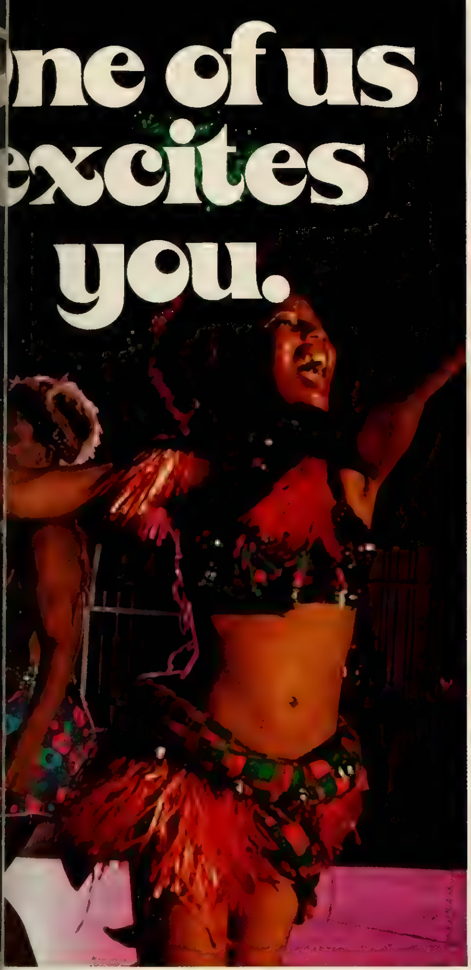
But the worst part of Nisbett's approach is his lack of understanding of the real forces that affect the development and use of scientific ideas. Historically speaking, it is important to analyze the forces behind the immense publicity given during the 1920s and 1930s to theories of biological (genetic and evolutionary) determinants of social behavior, of which Lorenz's ideas of instinct and innate aggression are only one example. This was the period during which eugenicists in the United States, Great Britain, Scandinavia, and Germany were espousing a genetic cause for all sorts of human behavioral and personality traits (alcoholism, feeblemindedness, prostitution, unemployment, and so on). Hereditarian arguments were given widespread publicity by wealthy interests at a time when capitalist economy was entering its most severe period of decline in the twentieth century (the Great Depression). Racism was on the rise and was given substantial justification by a variety of theories that claimed that social beahvior was a product of innate, rather than environmental, factors.

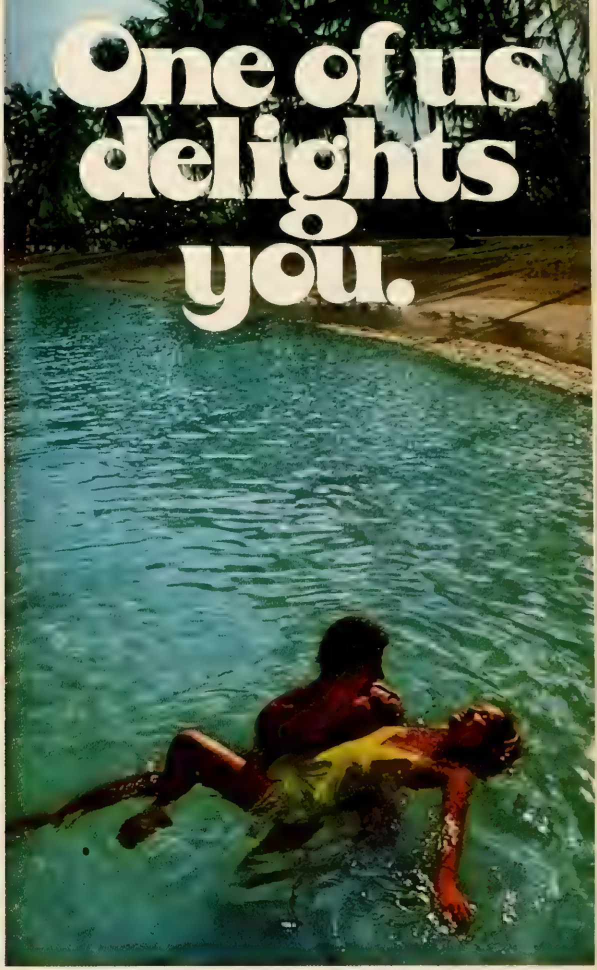
Nisbett's failure to consider the over-all scientific and social context of this period has caused him to miss the main point to be learned from a study of Lorenz's work. Scientists can play a powerful role in society—more powerful, sometimes, than they or the public are willing to admit. Ideas can become deadly weapons when they provide a supposedly objective and rational description for human social behaviors. Scientists need to understand the role their work can play in a social system where the control of the flow of ideas lies in the hands of those elite who have their own social aims in mind. Lorenz's
case exemplifies this point dra
cally. From his notions that man
cial behaviors are innate and
humans have an instinct for pre
ing the "purity of type," all el
his system follows. Lorenz w
respected scientist whose views
advertently or not, could be use
legitimize a brutal genocidal phil
phy. In killing Jews, Aryans
only "doing what comes natural

It makes little difference for a
alysis of history to argue whe
Lorenz saw the implications o
work in this direction or not.
study of history is not concerned
individual motivations, but with
behavior of large groups—class
who behave in accordance with
derlying social, political, and
nomic forces. Lorenz contribute
and was used by, one class (the
man ruling class, eventually re
sented by the Nazis) in its vai
tempt to maintain control over a
idly deteriorating social and
nomic system.

The historical lessons to be lea
from an analysis of Lorenz's c
are all the more important fo
today, when "doing what comes
urally" is rapidly becoming a ho
hold term. Our own era has see
rise of similar theories of biolo
determinants for social behavi
Arthur Jensen and William Sh
ley's notion that blacks are ge
cally inferior to whites in I.Q.
E.O. Wilson's *Sociobiology:*
New Synthesis, a monograph
maintains that many human socia
haviors, especially sex roles, are
etically determined and have bee
lected for during evolution. Ne
Jensen and Shockley nor Wilson
any more evidence than Lorenz
the innateness of such human s
behaviors. Yet the immense p
that these recent theories have
ceived is no less startling in our
than was that which Lorenz rece
in his. Lorenz's case ought to hel
see that the prevalence of s
theories (not just one theory,
many of similar ilk) can pave the
for a holocaust. It is not a perver
of history to try and learn from
past. Books like Nisbett's could
tentially make an enormous contr
tion in that direction. That this
ent biography does not is a great
appointment.

Garland E. Allen is an associate
fessor of biology at Washington
versity, Saint Louis, Missouri.





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German cities, the decline he pic
is true of the urban scene ir
country as well.

Without using a line of text, M
has pinpointed an urgent coı
porary dilemma.

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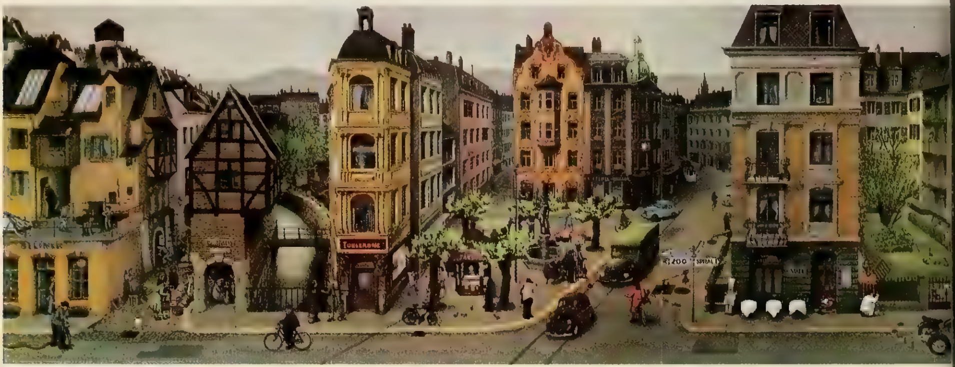

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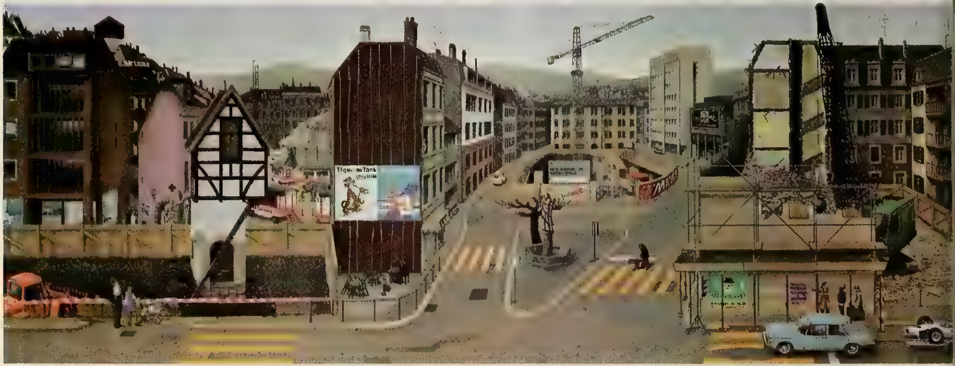

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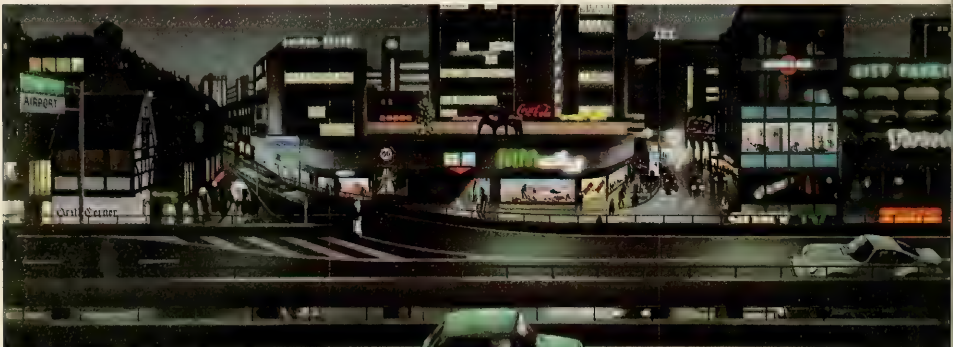

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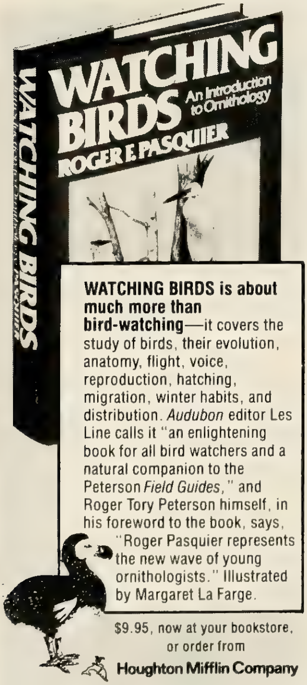

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A Matter of Taste

Oranges and Their Cous

The great success of citrus fruits in America has turned the exotic into the ordinary

Driving through Bradenton, Florida, this winter, just after the frost had laid waste thousands of fruits in the commercial orange groves and sent local prices climbing, I thought of another cold day fourteen years ago in London. My wife, who was writing a paper on Paolo Uccello, and I had come to look at one of the painter's famous battle scenes in the National Gallery. As it happened, the picture was being restored, and so, after addressing ourselves to the appropriate authorities, we were ushered backstage, as it were, to a large yet still-cluttered room where, hard by Rembrandt's *Polish Rider*, we found our Uccello, partly cleaned, but visibly in need of more work. The restorer had, however, already earned his keep. In the background of the stylized affray we knew from reproductions, he had uncovered orange trees: bright, luxuriant, fruiting orange trees.

They are the only instant oranges I have ever come across. My surprise and delight at seeing them were probably irrelevant reactions to the painter's intentions, but Uccello must have put them in to add an exotic, rich strain as a symbolic counterpoint to the choreographed havoc that was his main subject.

Oranges and their citrus cousins always, until quite recent times, brought a warm, bright, comfortable whiff of the semitropics to people who ate them in northern climes. Seventeenth-century Dutch painters of luxurious still lifes liked to place elegant spirals of citrus peel among high-priced crystal and gold objects. As recently as 1923, Wallace Stevens wrote deliciously of "complacencies of the peignoir, and late coffee and oranges in a sunny chair."

Since then, oranges and lemons, limes and grapefruits have lost their aura for Americans. Botanists may once have compared oranges to the golden apples of the Hesperides, but
the enormously successful citrus
dustries of Florida and Califo
have turned wonder into routine.
United States is the leading citrus
ducer in the world. This, combi
with easy transport, artificial riper
with ethylene gas, and cle
methods of propagation thro
grafting and budding, has made ci
fruits and juices a cheap and b
fact of American life. Frenchr
may still regard orange juice ta
neat as an unusual indulgence (as
might consider freshly squee
mango juice), but for most of
orange juice is simply O.J., so
thing we take with breakfast
don't think twice about.

While passing through all that v
ened, spoiled fruit, I thought, perh
the inevitable rise in price will rem
people that oranges are import
Perhaps some who now settle
truly banal juice made from ar
cially "balanced" concentrate
go back to squeezing their o
oranges. Others may even rever
peeling whole oranges. That co
lead to a wave of citrus connoisse
ship now limited to those Florida r
dents and northern fanatics who in

by Raymond Sokolov

resh, naturally ripened fruit
n for its taste and texture.

spite the freezing temperatures,
y marketed oranges, grape-
, and tangerines in Florida this
r dramatically outclassed any
fruit I have eaten at any time
north. I found myself gobbling
uats, which are sour but delec-
morsels eaten peel and all. And
the time—well spent—to peel
-laden tangelos.

e classic method is a bit messy
laborious, but it pays off, for
ges as well as tangelos. You cut
the peel in a thin, curving strip,
g with a small knife just deep
gh so that all the white albedo of
nner peel comes away with the
ed outer flavedo. This peel con-
aromatic oil glands, which im-
lavor to cocktails when the peel
sted over the drink and then im-
ed in it. The flavedo can also be
to flavor desserts of all kinds (see
es below).

side the peel, as everyone
s, is a cluster of juicy sections.
areful person will cut away each
on so as to remove the encasing
branes. Eventually, one is left
with a luscious pile of orange sections on one side and a heap of membranes on the other. After squeezing the residual juice out of the membranes into a glass, you have only to rinse off your hands and eat the fruit.

Angel Soccodato

This procedure will work with nearly all citrus fruits (although it is essentially unnecessary with tangerines and other "zipperskins"), graphic proof that they are relatives. Taxonomists looked to this similarity when they lumped all these specialized berries, or hesperidia, into the subdivision Citreae of the rue family Rutaceae. The Citreae are further divided into three subtribes, of which the true citrus group is the one that includes oranges *et al.*

Actually, the true citrus group includes six genera. Three are of no practical interest and are limited to Australia, New Guinea, and the island of New Ireland in the Bismarck Archipelago. *Poncirus* is the genus of the trifoliate orange, whose hardy rootstock hybridizes conveniently with grafts and buds from other citrus. Kumquats have the *Fortunella* genus pretty much to themselves. And last, but obviously not least, the genus *Citrus* contains all the other edible citrus fruits.

Thorny shrubs, white flowers, compound leaves, hesperidial fruit (in sections encased in membranes and housing easily ruptured juice vesicles), juice rich in organic acids (notably ascorbic acid, or vitamin C) and carotene (vitamin A)—these are the common traits of the citrus plants we know and eat. They mutate frequently and hybridize easily among each other. Their seeds are either zygotic (genetic mixtures of male and female parents) or nucellar embryos, which contain only the genetic information of a single female plant. Nucellar seeds will produce plants identical to the ones that they grew on, an advantage usually limited to plants grown from grafts or buds on a host rootstock or by other vegetative means.

Modern citrus growers rejoice in this state of affairs, which has made

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genetic engineering with citrus trees comparatively easy. They can either graft disparate species onto each other with ease or they can grow seedlings without the risk of unsuccessful variation that threatens seed propagation in many other plants.

But citrus men have also inherited a complex legacy from less scientific millennia, during which citrus genes blended and intertwined to produce a thicket of varieties too tangled to sort out cleanly in the greenhouse or in the field. Indeed, horticulturists have sometimes reproduced hybrids that had already appeared in nature, while for most species it has been impossible to locate wild progenitors.

The citrus diaspora began in prehistoric times in northeast India. By 136 B.C., Simon the Maccabee was ordering that citrons replace cedar cones in the Jewish harvest-festival ritual. Palestinian Greeks then conflated the two objects and kept the old name, which is why all citrus plants are now named after cedars (*kedros*). The citron (*Citrus medica*) was the first such fruit to reach Europe. This happened in Hellenistic times, after Alexander had opened up good lines of communication with the East. Eventually, it fell to Columbus, on his second voyage in 1493, to close the circle by transporting orange, lemon, and citron seeds to Hispaniola.

The West Indies have ever since been a rich ground for citrus evolution. A certain Captain Shaddock introduced the largest of all citrus fruits, *Citrus grandis*, to Barbados in 1696. Now known as the shaddock, or pompelmous, its flesh has not won many adherents. But during the eighteenth century, shaddocks mutated into a more delectable fruit that grew in clusters like grapes and was therefore dubbed the grapefruit in Jamaica. The name stuck, despite efforts on the part of horticulturists to rename it "pomelo." The grapefruit (*C. paradisi*) reached the United States in 1823, when a French settler, Odette Philippe, planted seeds or seedlings from the Bahamas near Safety Harbor on Tampa Bay. All modern American varieties are said to descend from this original planting (red and pink varieties are mutations). And since this country now produces 90 percent of the world's grapefruit crop, Dr. Philippe deserves an important place in the pantheon of American economic botany.

Mandarins are the zipperskin f we lump together as tangerines. tually, tangerines (*C. reticulata* only one of three species in group. They came to England f Morocco. The various satsumas (inated in Japan in about 1600 by tation from Chinese seeds and l been grown in Florida on trifo orange rootstock since 1876. Rep edly the best of the mandarins, "king" orange arrived from Sa in California in 1880. It has panned out commercially on scale because of difficulties in cul tion and because the rind is rough visually unappealing.

A complete survey of all the c species and varieties now grow the United States would stretch and on. But I cannot pass silently the exotic hybrids, which alr confuse the supermarket citrus b and may do so increasingly as n and better varieties reach the shel Astute fruit fanciers have long s warmed to the tangelo, a combina of tangerine and grapefruit (pom But commercial names such as M cott and Temple conceal the fact both these fruits (which peel ea and taste more or less like oran are tangors (tangerine plus oran The Temple orange is named W.C. Temple, the citrus mogul promoted it, beginning about 1 after a neighbor in Winter showed Temple the interesting fruit that had sprung from Jama budwood on his property.

We must not forget the umat which resembles the tangelo, but fact the result of pooling the tal of blood oranges and satsumas. T are also orangelos, which look grapefruits but lack their acidity aroma because of the admixtur orange to the grapefruit type. Li quats are key limes paired with k quats, brainchildren of the legen citrus experimenter W.T. Swin who hoped, during his lime phase in 1909, that this hybrid w be hardy enough to extend Amer lime cultivation northward and wrest away Mexico's lime supr acy. The limequat never caught Neither have such genetic curios as the citranges, citrumelos, an trangequats (respectively, trifo orange plus orange, trifoliate or plus grapefruit, and citrange kumquat). The dictionary does, h ever, mention a bitter drink calle trangeade, but I do not expect ev taste it. Nor do I look forward

of citrangedins, hybrids of ci-
: and calamondin (*C. mitis*), the
false lime.

l, when I hear about the new,
, easy-peeling hybrids of tan-
:s and tangleos now under de-
ment, my taste buds perk up.
all, every citrus variety I like is
n-made to some extent, hybri-
out of a primeval shrub's fruit.
can say that perfection has al-
been attained?

Colombian Orange Puffs

The Dumpling Cookbook, by
Polushkin. Workman Publish-
o.)

ıps all-purpose flour, approxi-
ıately
ıblespoons sugar
aspoon salt
ıblespoons butter
ıp freshly squeezed orange
ıice
ıblespoon grated orange peel
ups vegetable oil for deep fry-
ıg
onfectioner's sugar

a medium bowl, sift together
e flour, sugar, and salt. Add the
ıtter, orange juice, and orange
el and mix to form a stiff dough,
ding extra flour if necessary.
move the dough to a floured
ıard and knead for about 10 min-
es or until the dough feels
ıooth and satiny. Cover and let
ınd a half hour.
ıll out the dough as thin as possi-
e. Use one or several cookie cut-
rs to cut out shapes you like.
at the vegetable oil to 360 de-
ees.
op the dough pieces into the hot
l and fry for 3 minutes or until
ıffy and golden brown. Fry no
ore than 4 to 6 fritters at one
ne.
move with a slotted spoon and
ain on absorbent paper. Repeat
ıtil all are done.
rinkle with confectioner's sugar
ıd serve.

Yield: 4 to 6 servings.

Tarte au Citron

ıon tart as prepared at the Midi-
ıit Restaurant, Lyon)

ups sifted flour
up plus 3 tablespoons sugar
ıound unsalted butter
ablespoons shortening
gg, beaten with 1 teaspoon
vater
1¼ cups blanched almonds
Peel of 2 large lemons
3 egg yolks

1. Prepare a cookie dough crust (pâte sablée) with the flour, 7 tablespoons of the sugar, 5 tablespoons of the butter, and the shortening. Blend the butter and shortening quickly with your fingertips or a pastry blender or two forks, until the dough reminds you of oatmeal. Blend in the egg and gather the dough up into a ball. Press it in a long smear across the work surface with the heel of your hand. Re-form the ball and refrigerate in a plastic bag for several hours, until firm.
2. Just before you are ready to roll out the dough, preheat the oven to 300 degrees, grease the surface of a cookie sheet and prepare the filling for the tart: grind the almonds in a nut grinder or whirl in the blender, turning the machine off and on several times to minimize the release of oil from the nuts. With a vegetable peeler, cut away the yellow part of the lemon peels; chop this lemon zest as finely as you can. Beat together the remaining sugar and remaining butter. Then beat in the egg yolks, the ground almond, and the chopped lemon zest.
3. Roll out the crust until it is a circle about 14 inches in diameter. Put a greased 10-inch flan ring on the cookie sheet. Place the dough over the ring and push it snugly against the inner sides of the ring. Run a rolling pin across the top of the ring to cut away excess dough (which can be reserved to make cookies). Push the dough up over the top of the ring all around to about ⅛ inch above the ring. Press with the back of a knife against the rim.
4. Pour the almond/egg/lemon filling into the tart shell. It should come about three-quarters of the way up the side of the shell. Bake until the crust browns nicely and the filling has set, about 40 minutes.
5. When the tart is done, lift off the ring (cut it loose with a thin knife if necessary) and slide the tart onto a serving dish. Let cool before serving.

Yield: 8 to 10 servings

Raymond Sokolov's most recent cookbook is The Saucier's Apprentice, *a guide to French sauces.*

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QUESTAR 700

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Diameter	4⅜ inches
Weight	4 pounds
Filter Provisions	35 mm.

Additional Reading

Cemeteries (p. 32)

The nineteenth-century need for more burial space and for places of respite from cities is discussed in Thomas Bender's "The 'Rural' Cemetery Movement: Urban Travail and the Appeal of Nature" (*The New England Quarterly,* June 1974, pp. 196–211). In Stanley French's article, "Cemetery as Cultural Institution" (*American Quarterly,* March 1974, pp. 37–59), Mount Auburn, the first landscaped cemetery in the United States, is described in the context of the rural cemetery movement. "From Monument to Place," by J.B. Jackson (*Landscape,* 1967–68, pp. 22–26), is a historical synopsis of the development of the American cemetery as a planned environment. Wildlife, too, uses old cemeteries, as described by Jack Ward Thomas and Ronald A. Dixon in "Cemetery Ecology" (*Natural History,* March 1973, pp. 60–67). "Death's Head, Cherub, Urn and Willow" by James Deetz and Edwin S. Dethlefsen (*Natural History,* March 1967, pp. 28–37) is an earlier study of tombstones. Edmund V. Gillon's *Victorian Cemetery Art* (1972), illustrated with 260 photos, is available in paperback for $4.00 from Dover Publications, New York. A useful guidebook is *New England Cemeteries: A Collector's Guide,* by Andrew Kull (Brattleboro: Greene Press, 1975, $9.95 hard-cover; $5.95 in paper). Harriet Forbes's *Gravestones of Early New England and the Men Who Made Them, 1653-1800,* available in paperback for $6.95 from the Pyne Press, Princeton, is a 1973 reprint of the original 1927 edition. *The American Way of Death,* second edition, 1975, by Jessica Mitford, available from Fawcett Crest Books, New York, for $1.95, puts early American attitudes toward death into modern perspective.

Monarch Butterflies (p. 40)

Butterfly migration is one of the subjects covered in Klaus Sch Koenig's illustrated text, *Migi and Homing in Animals* (New Springer-Verlag, 1976). A s text covering the subject of de against predators is *Defence in mals,* by Malcolm Edmunds York: Longman, 1974). This B work, including an extensive bil raphy, is available in paperbac $14.50. Author Lincoln Browe also written on the use of milk as a butterfly defense (*Scie American,* February 1969, 22–29). The announcement o first discovery of a Mexican wint spot for the monarch may be f in F.A. Urquhart's August 197 *tional Geographic* article, "Fou Last: The Monarch's Winter Ho *Butterflies, Their World, Their Cycle, Their Behavior* (New Alfred A. Knopf, 1975) is a b fully illustrated work on butterfly logy and behavior with text by versity of Florida professor Th C. Emmel, photographs by Ed S. Ross and others, and drawin Walter Hortens. Anyone interest butterfly observation may wish t tain Alexander B. Klots's *Guide to the Butterflies* (Bo Houghton-Mifflin, 1951, $5.95)

Alligators (p. 54)

Edward A. McIlhenny's pers account of Louisiana alligators, *Alligator's Life History* (Bo Christopher Publishing Ho 1935), contains many observa that later research has proved t accurate. A 1976 reprint editio this work may be obtained fron Publishing Section, Society fo Study of Amphibians and Rept Department of Zoology, Miami versity, Oxford, Ohio 45056, cost of $12 (paperback) or $15 (h cover). A useful overview of both tinct and living crocodilian Wilfred T. Neill's *The Last o Ruling Reptiles: Alligators, Cr diles, and Their Kin* (New York:

ia University Press, 1971). Bamford Cott's *Looking at An- s: A Zoologist in Africa* (New .: Charles Scribner's Sons, 1975) ins a very readable illustrated on on the Nile crocodile. An- y C. Pooley and Carl Gans's e Nile Crocodile'' (*Scientific rican,* April 1976, pp. 114–24) nteresting color photographs as as maps and diagrams. Two re- important papers on the natural ry of alligators appear in the *Pro- ings* of the Southeastern Associ- of Game and Fish Commis- s' Annual Conferences: T. en's ''Nesting Ecology of Alli- s in Louisiana'' (from the 23rd ual Conference, 1969, pp. 51), and T. Joanen and L. Mc- e's ''A Telemetric Study of t Male Alligators on Rockefeller ge, Louisiana'' (26th Annual erence, 1972, pp. 252–75). e may be available in a large uni- ty library—or the reader should is or her librarian to obtain them iterlibrary loan. ''Social Signals Behavior of Adult Alligators and odiles'' (*American Zoologist,* ', vol. 17, pp. 225–39), a recent w paper by Leslie Garrick and ey Lang, authors of the article in issue of *Natural History,* com- s the behavior of three croco- n species. ''Night of the Croco- '' by J.C. Ogden and C. Single- (*Audubon Magazine,* May 1973, 32–37), features photographs of ld crocodile nest during a hatch-

h Litter (p. 62)

ore and Beach, the monthly sletter and semiannual magazine e American Shore and Beach ervation Association, while con- ed largely with erosion and other ical changes in beaches, also s such issues as littering and gov- ental planning for beach use. *e and Beach* is available for 0 annually from the ASBPA, 10 Rickenbacker Causeway, Miami, Florida 33149. An annotated bibliography on man's recreational impact on natural resources is available from Wildland Recreation Research Project, Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture Forest Service, 4507 University Way NE, Seattle, Washington 98105. Bruce E. Bechtol and Jerry R. Williams have written two other articles on litter: ''The Litter Census as a Tool in Geographic Education'' (*Journal of Geography,* November 1972, pp. 468–72) and ''Is the Aluminum Container a Viable Alternative to Oregon-Style Legislation?'' (*Modern Brewery Age,* May 31, 1976, pp. 22–23), which describes littering patterns at twenty-three California sites.

Lightning (p. 66)

Two recent works on lightning, available at low cost, are Martin A. Uman's *Understanding Lightning* (Carnegie: Bek Technical Publications, 1971, $6.50) and Peter E. Viemeister's *The Lightning Book* (Cambridge: M.I.T. Press, 1972, $2.95 in paperback). The latter is profusely illustrated and contains appendixes with such useful information as sources for safety codes and other publications, lightning-related equipment, and addresses of key organizations. Two worthwhile English publications are *Physics of Lightning,* by D.J. Malan, an Applied Physics Guide (London: English Universities Press, 1963), and B.F.J. Schonland's *The Flight of Thunderbolts* (Oxford: Clarendon Press, second edition, 1964), which incorporates the Greynog Lectures that Schonland delivered in 1960 at the University College of Aberystwyth. Plenum Publishing, New York, has in print two books on ball lightning: *The Nature of Ball Lightning,* by Stanley Singer (1971) and *Ball Lightning,* by Donald J. Ritchie (1961).

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Celestial Events

by Thomas D. Nicholson

Sun and Moon The sun moves from the constellation Taurus into Gemini on June 20 and arrives at the summer solstice on June 21. It continues eastward in Gemini into July, passing south of Castor and Pollux about the 15th, finally entering Leo on August 10. A few days later, on August 13, it passes the planet Saturn. Now in the most northerly part of its apparent sidereal path, the sun spends nearly 14½ hours above the horizon daily.

Expect a morning moon during the first half of June, July, and August and an evening moon during the last half, with new moon occurring about mid-month and full moon near month's end. Phases in June are last-quarter on the 8th, new on the 16th, first-quarter on the 24th, and full on the 30th. In July: last-quarter on the 7th, new moon on the 16th, first-quarter on the 23rd, and full moon on the 30th. Last-quarter will occur again on August 6, new moon on August 14. Perigee moon is on June 1, June 29, July 27; apogee on June 14, July 12, August 8.

Stars and Planets There are no planets on the Star Map this month, because none are above the horizon at map times. Mercury is an evening star for July, but sets too early for good observing. Saturn is also in the evening sky through August 13, low in the west for several hours after sunset in June and early July, but poorly placed after that.

The morning planets are better located. Venus is dominant in the east for several hours before sunrise and quite brilliant (although dimmer than it was in May, it is better positioned for viewing). In early June, Mars will be near the brighter Venus. Look on the morning of June 12, when the late crescent moon will pass by them. Jupiter will show up as a morning star by early July, low in the east before sunrise, below Venus. The distance between these two planets will decrease until the end of July, when they are quite close; it will then increase slowly in August. Jupiter, Venus, and the crescent moon will be impressive on the morning of July 13 and again on August 11.

June 3: Venus is in conjunction with Mars.

June 4: Jupiter, in conjunction with the sun, enters the morning sky.

June 13: Earliest sunrise of the year.

June 15: Venus is at its greatest distance from the sun in the morning sky.

June 20: Saturn is near the moon tonight.

June 21: Solstice. Summer in the Northern Hemisphere begins at 7:14 A.M., EST.

June 28: Latest sunset of the year.

June 29: Mercury enters the evening sky.

July 5: Earth is at aphelion, farthest from sun (94,500,000 miles).

July 11–12: The late crescent moon passes Mars and Venus in the morning sky.

July 13: Jupiter is near the moon this morning, below Venus.

July 29: Maximum of the Delta Aquarid meteor shower.

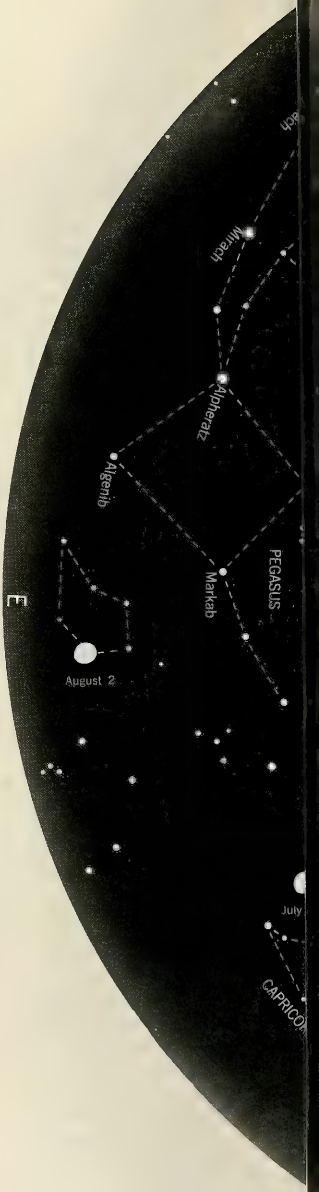
July 30: Venus is in conjunction with Jupiter, separating thereafter to the east (below Jupiter).

August 8: Mercury is at greatest elongation in the evening sky.

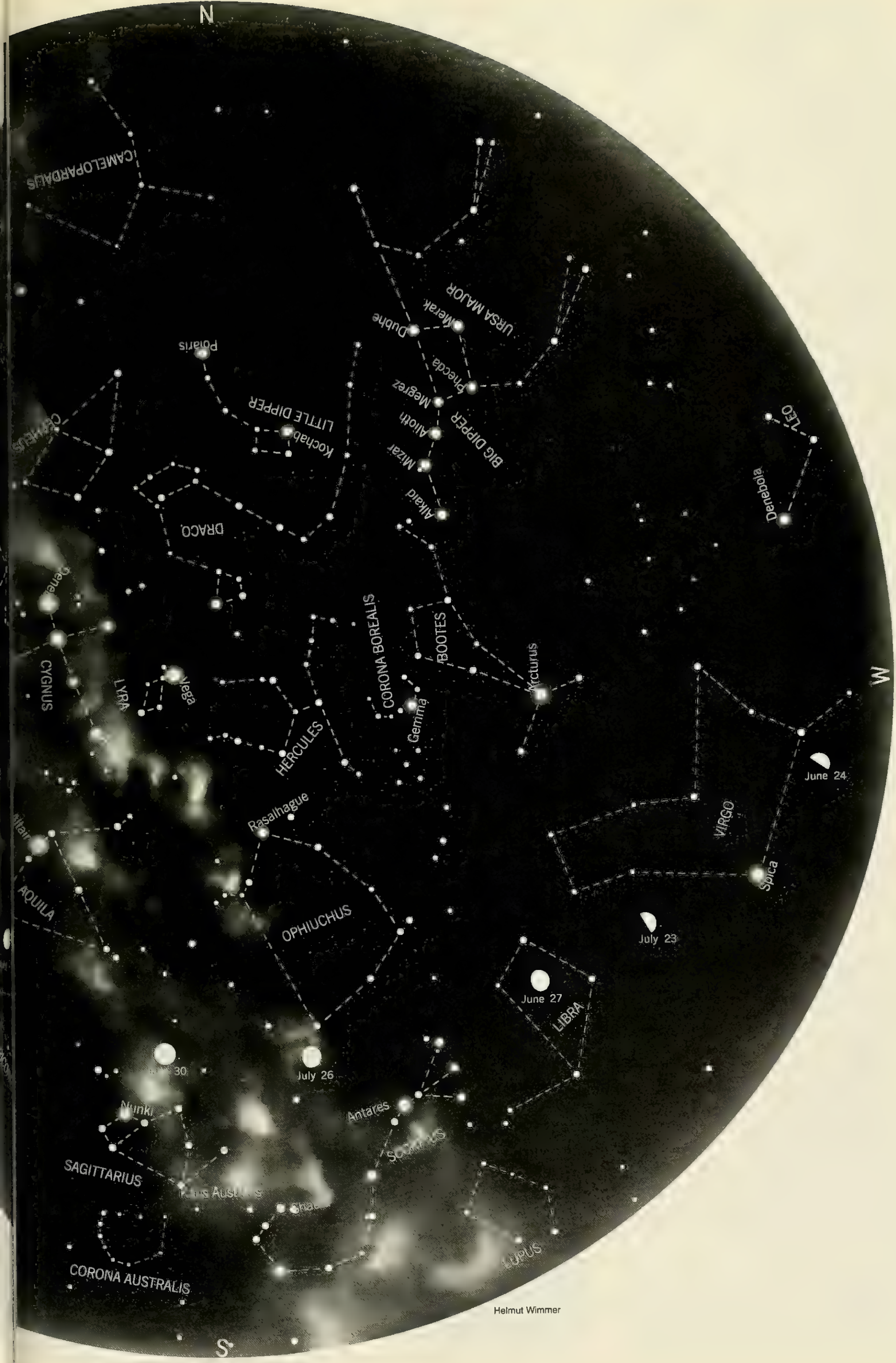
August 9–10–11: The moon passes Mars, Jupiter, and Venus in the morning sky, coming closest to each on successive mornings.

August 12: The rich, impressive Perseid meteor shower reaches maximum.

August 13: Saturn, in conjunction with the sun, becomes a morning star.



★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 1:15 A.M. on June 1; 12:20 A.M. on June 15; 11:25 P.M. on June 30; 10:25 P.M. on July 15; 9:20 P.M. on July 31; and 8:20 P.M. on August 15; but it can also be used for an hour before and after those times.


N
W
S
CAMELOPARDALIS
URSA MAJOR
Merak
Dubhe
Polaris
Phecda
Megrez
LITTLE DIPPER
Kochab
Alioth
BIG DIPPER
CEPHEUS
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LEO
Denebola
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Deneb
CORONA BOREALIS
BOOTES
CYGNUS
LYRA
Vega
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Gemma
HERCULES
June 24
VIRGO
Rasalhague
Altair
AQUILA
Spica
OPHIUCHUS
July 23
June 27
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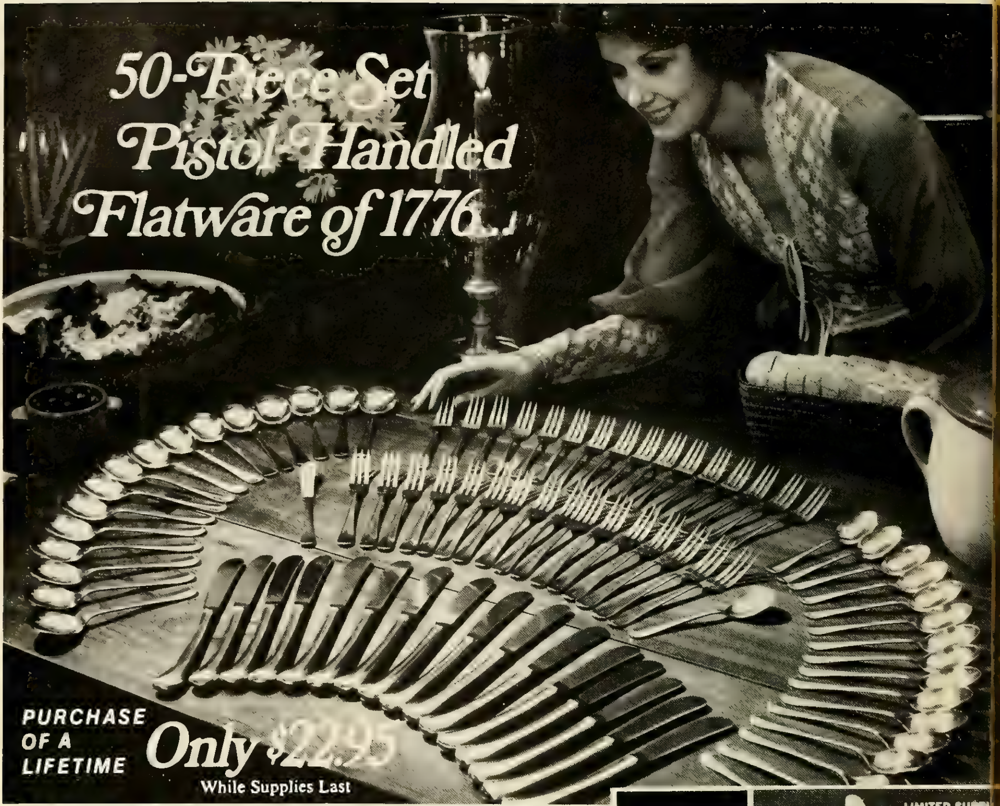
Announcements

The **Aeolian Chamber Players** will give two concerts, one for children and the other for adults, in the Museum's Auditorium during the weekend of June 11 and 12. This ensemble, founded in 1961, has a wide repertoire of contemporary and classical selections that are rarely performed. The group is noted for its unorthodox, imaginative playing techniques; for example, in their frequent rendering of "The Voice of the Whale," from George Crumb's *Vox Balarnae,* the flutist sings into the flute and the pianist strokes the piano strings with a chisel. The ensemble also plays works of other contemporary composers, such as David Burge's "Aeolian Music," Arnold Schoenberg's chamber symphony No. 9, and William Bolcolm's "Whisper Moon." The concert for children, June 11 at 11:00 A. M., will emphasize pieces based on folk music and is free to all participating and donor members of the Museum. Associate members and the public will be charged 50 cents per ticket. The second concert will be on June 12 at 3:00 P. M. Tickets, available by mail order or at the second floor information desk, are $3.00 for participating and donor members, and $4.00 for associate members and the public.

More than 100 specimens of **Cones and Cowries,** two colorful shell types favored by collectors, will make up an exhibit in the Roosevelt Rotunda. A short time ago, the Museum was given two unusual shells: one a species of cone shell, *Gloria maris,* or glory of the sea; the other, a species of cowrie, *Cytraea valenti.* These two specimens form the basis of the exhibit, which will run from June 15 through August.

A photo exhibit honoring **Margaret Mead,** curator emeritus of ethnology at the American Museum, will continue throughout the summer in the Akeley Gallery on the second floor. The display includes photographs of Mead as a child, as a student, as a young anthropologist interviewing South Pacific islanders, and more recently, as a well-known lecturer and panelist. The display consists of both black-and-white prints and projected color transparencies.

An exhibition of **Maps—Their Science and Their Arts,** in Gallery 77 on the first floor of the Museum, explains map scale and projection, the use of latitude and longitude, and the kinds of instruments used in map making. Many of the maps are of New York City: some are historical, showing the growth of the city, while others explain the city's different aspects—school districts, water supply routes, topography. Also displayed are maps used by other societies. Examples are a reproduction of an Aztec codex and a birchbark map used by American Indians. Most of the maps are on loan from the Museum's various departments and from such institutions as the American Geographical Society and the U.S. Geological Survey.



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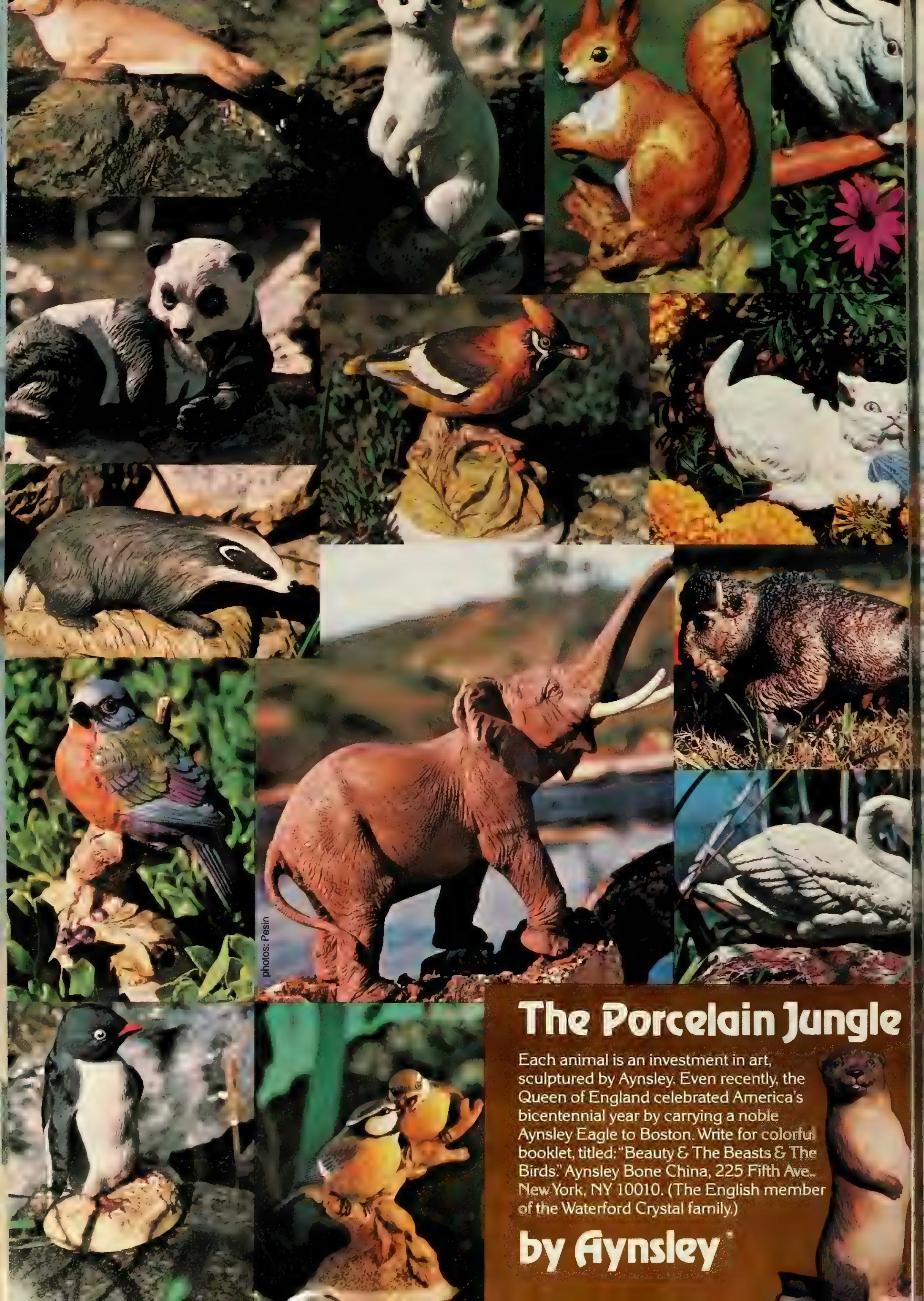
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NATURAL HISTORY

Incorporating Nature Magazine
Vol. LXXXVI. No. 7
August-September 1977

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Robert G. Goelet, President
Thomas D. Nicholson, Director

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Authors

A leading figure in the technique of culturing human cells, microbiologist **Leonard Hayflick** is affiliated with the Children's Hospital Medical Center, Bruce Lyon Memorial Research Laboratory, Oakland, California. He has served in the past at the Wistar Institute in Philadelphia and worked and taught at Stanford University School of Medicine in California. Hayflick received his Ph.D. in medical microbiology and chemistry from the University of Pennsylvania in 1956. His research plans include a project involving the reconstruction of human cells from isolated nuclei and cytoplasms.

Elizabeth Mathias, right, is associate professor of anthropology at Saint John's University in New York City's borough of Queens. Her work has centered on Italian-American folk religion in south Philadelphia, and on life in a Sardinian shepherd village. **Sister Mary Ann Borrello,** left, of the Dominican order of Our Lady of the Rosary, is assistant professor of sociology and anthropology at Suffolk County Community College on Long Island, New York. While teaching in the South Bronx, in
1960s, Borrello first became awar
spiritism's pervasiveness am
New York's predominantly Ror
Catholic Puerto Rican communi
when she asked her Puerto Ri
grade school students what tl
mothers did when the children w
ill. In 1975, one of Mathias's coll
students invited her to a spiritist ce
mony. Borrello went along, an
joint study of *botanicas* and Pue
Ricans' dual religiosity began.

"For the past two years I have been, in a sense, a migrant worker," writes **Christopher Cauble.** In the summertime he worked for the National Park Service in Alaska; winters he settled in the mountains of Montana to pursue free-lance writing. Cauble's interest in grizzlies became firmly entrenched in 1972 when, alone on a backpacking trip in Mount McKinley National Park, a sow grizzly attempted to sink her teeth into a selected part of his anatomy. He has encountered more than a hundred grizzlies in the backcountry of Mount McKinley, Glacier, and Yellowstone national parks, and at Katmai National Monument in Alaska. Cauble is working for the National Park Service in Katmai this summer

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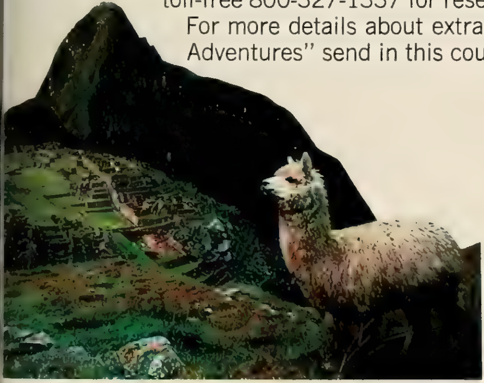

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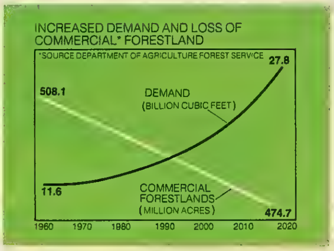


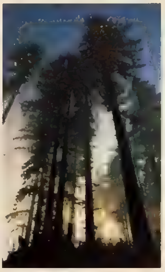
The chart above shows that U.S. consumption of all wood and paper products will double in less than 50 years. Thus the reason behind Operation Double Tree—the forest industry's name for intensive forest management that can double the amount of wood grown on a given piece of land. And do it in such a way that the forest remains a valuable part of the ecosystem.

**Commercial forest is described as that portion of the total forest which is capable of, and available for, growing trees for harvest. Parks, wilderness and primitive areas are not included.*

The two Douglas firs to the right grew in the forests of the Cascade Mountains of Washington State. Both were harvested when they were 25 years old. The difference is, the larger one grew in an Operation Double Tree area, while the smaller one did not.

Double Tree is ambitious and is already working.

All across the U.S., forest product companies are working to double forest yield. In Oregon and Washington, forest product companies are predicting


West

South

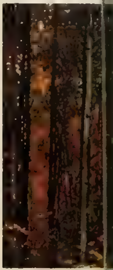
triple growth with genetically superior trees planted in prime forestlands.

Through thinning efforts alone, some companies in the Great Lakes States have increased diameters of remaining trees enough to double wood volume per acre over a 35-year period.

Double Tree isn't limited to large
trial tree farms. Individual w
owners from Maine to Georgia a
ting idle lands to work, creating
belts that offer the twin payoff
increased harvest *and* eternal f

That may sound like a parad
eating a cake and having it, too.
like oil or coal, wood is one natu
source that is *renewable*. And r
forestry has found ways to make
Nature more productive.

Great Lakes


New England

Today's intensive forest manag
is rooted in nature's own ecological c
begins with the harvest. Slower g
trees are thinne
Others are ha
at peak g
And

Actual tree diameter 9 3/16"

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pt is made to use every last part of e: tops, limbs and bark.

lew Forest.

3ut the real key is in the *new* for- he new trees.

n some areas, foresters plant new ngs by machine, or by hand. Heli- 's are also used to re-seed. When seedlings go in, the forest often five-year head start over natural eration in the same area.

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Significantly, the principles of Operation Double Tree are being used on only a small portion of America's forestland. And good as Double Tree is, it might not be enough. Too much of the American forest is still under-utilized and under-productive.

Overall, industrial forestlands are working the hardest. Industry owns only 13 percent of the commercial forestland, but it provides almost 30 percent of the total harvest. Some 4 million private individuals own 60 percent. Government owns about 27 percent.

All of which means we must join to make the most productive use of our remaining commercial forestland. Industry has invested millions to make the concept a reality. But money isn't enough. Leaders and landowners alike must understand the problem. And, more important, the solution.

For more information, write for our free booklet "Managing the Great American Forest," American Forest Institute, P.O. Box 873, Springfield, VA 22150.

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Letters

A Turtle Vanishes

Jim Cooper's article "Vest-pocket Turtle" (April 1977) stimulated us into a weekend field trip to photograph *Kinosternon flavescens spooneri,* its habitat, and other eastern Iowa sand prairie fauna on Muscatine Island.

Hopeful and anxious to locate a live Illinois mud turtle, we were disappointed. A careful search of the first pond we encountered revealed the remains of seven dead *spooneri.* At the second pond, we discovered that some disaster had also befallen its chelonian population. Walking one-third of this larger pond's shoreline, we counted fifty dead turtles representing four species, including one more *spooneri.* The area we surveyed was small, so hopefully there are other ponds harboring *spooneri* which did not meet the same fate.

The cause of the turtles' death is not known to us. The very severe winter combined with a low water level in the ponds could have caused many turtles to freeze. A chemical plant nearby may be using the ponds for waste disposal. In any case, "the largest known population of the Illinois mud turtle" is in trouble, if not destroyed.

If a viable population of *spooneri* survives on Muscatine Island, the future may be no brighter than the present. The northern end of Big Sand Mound is owned by a large chemical company, and the rest has just been purchased by an electric company as a site for a generating plant. Though the power company has proposed setting aside some unused acres as a "nature preserve" when construction starts this fall, the needs of a generating plant and a rare semiaquatic turtle may not coincide. Where there is a clash, it's doubtful that the power facility would be modified to preserve turtles.

All populations of the Illinois mud turtle should probably be listed as endangered by the Office of Endangered Species, U.S. Fish and Wildlife Service. Federal endangered status would not only protect individual turtles, but such listing would allow "critical habitat" designation for Muscatine Island and similar areas. This typ protection would preserve not the "vest-pocket turtle," but the tire sand prairie fauna.

JOHN C. MUR
Plainfield, Illi
MICHAEL J. C
Grayslake, Illi

Animal Traffic

Jean-Yves Domalain's "Con sions of an Animal Trafficker" (N 1977) correctly describes how trad in illegal wild animals can occur cause of the disinterest of some g ernment officials and bribery others, and how some callous deal grossly mistreat animals, but it inc rectly reports many other aspects the international trade in live wild imals. The author is only partly ac rate in detailing the collection/sh ping end of the animal trade t exists in parts of Southeast Asia, is frequently inaccurate when scribing the purchasing/receiving of the trade in Europe.

Far and away the greatest num of live wild animals sold internati ally or domestically go to the pet m ket, not to zoos and circuses. For ample, U.S. Fish and Wildlife Se ice records for 1970 and 1971 in cate that 95 percent of the wild bi imported into the United States w for sale as pets to private citize About 4 percent were sold for b medical research and less than 1 p cent were destined for zoos. The mainder were imported by wildl agencies and other special interes At the same time, about 44 perc of the imported wild mammals we sold as pets, 54 percent went to b medical research, and less than 2 p cent to zoos and aquariums, with t remaining fraction for wildlife a agricultural purposes. Wild bird i ports for 1973 and 1974 were rough similar, with 98 percent destined f pets and less than 2 percent for zoo

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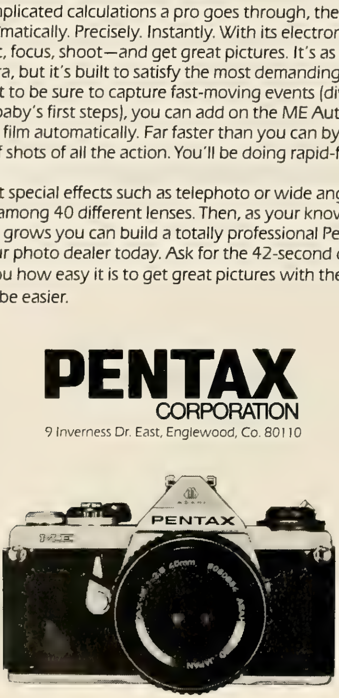

In 1973, only 30 percent of the n mals were imported for sale as p while 60 percent were brought i biomedical research. Approxima 4 percent went to zoos aquariums.

Domalain knows that the maj of live wild animals are sold to pri pet keepers, but he chose to down that fact in favor of attacking the more conspicuous zoos. And his customers were primarily French stitutions, possibly the least kn edgeable and/or least humane of zoos on the European continent.

A good many North American European zoos were among the e supporters of efforts to elimi commercial trade in endangered c legal wildlife, by participating in untary boycotts prior to enactmen endangered species laws, pressing passage of the U.S. Endangered S cies acts, and actively participatin the drafting of the Convention on ternational Trade in Endangered S cies of Wild Fauna and Flora and domestic legislation that implem this treaty in the more than 30 nati that have ratified it to date. Sev zoological societies have global p grams aimed at conserving wild mals in their natural habitats.

In summary, author Domala experiences in trafficking in wild mals in Southeast Asia and sel primarily to French buyers, inclu some badly operated French zo has given him a biased understand of actual world trade in wild anim and of professional zoo operation

F. WAYNE K
Director of Zoology
Conserva
New York Zoological Soc

Less Litter

I hope you follow up "Califor Litter" (June-July) with other artic on the same problem.

We have found here in this sm corner of the Hudson Valley that annual "Litter Days" well-pul cized locally, do help. We make p ties out of them, ending a three-h litter-picking with a two-hour pic with songs. The total volume of li has slowly but steadily gone dow

Our *Clearwater* "sloop clu keeps a watchful eye on a small st park beach and a municipal wat front. At the latter we have torn do the insulting "No Littering $ Fine" sign, which no one, includ police, paid much attention to, a

(Please turn to page

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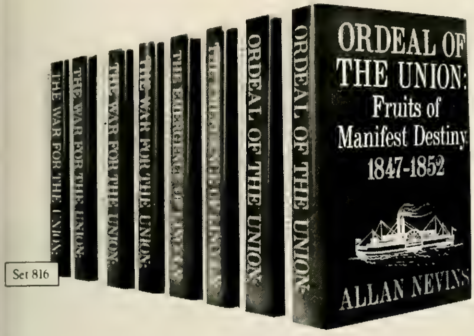

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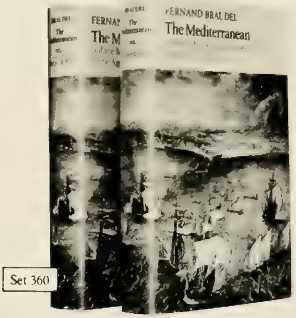

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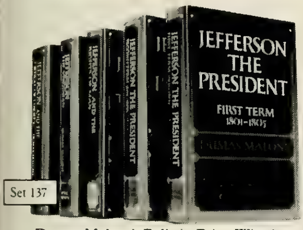

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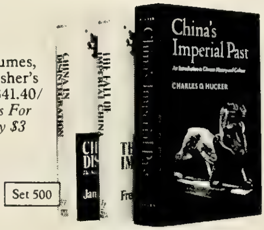

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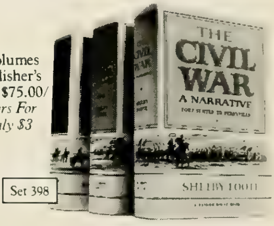

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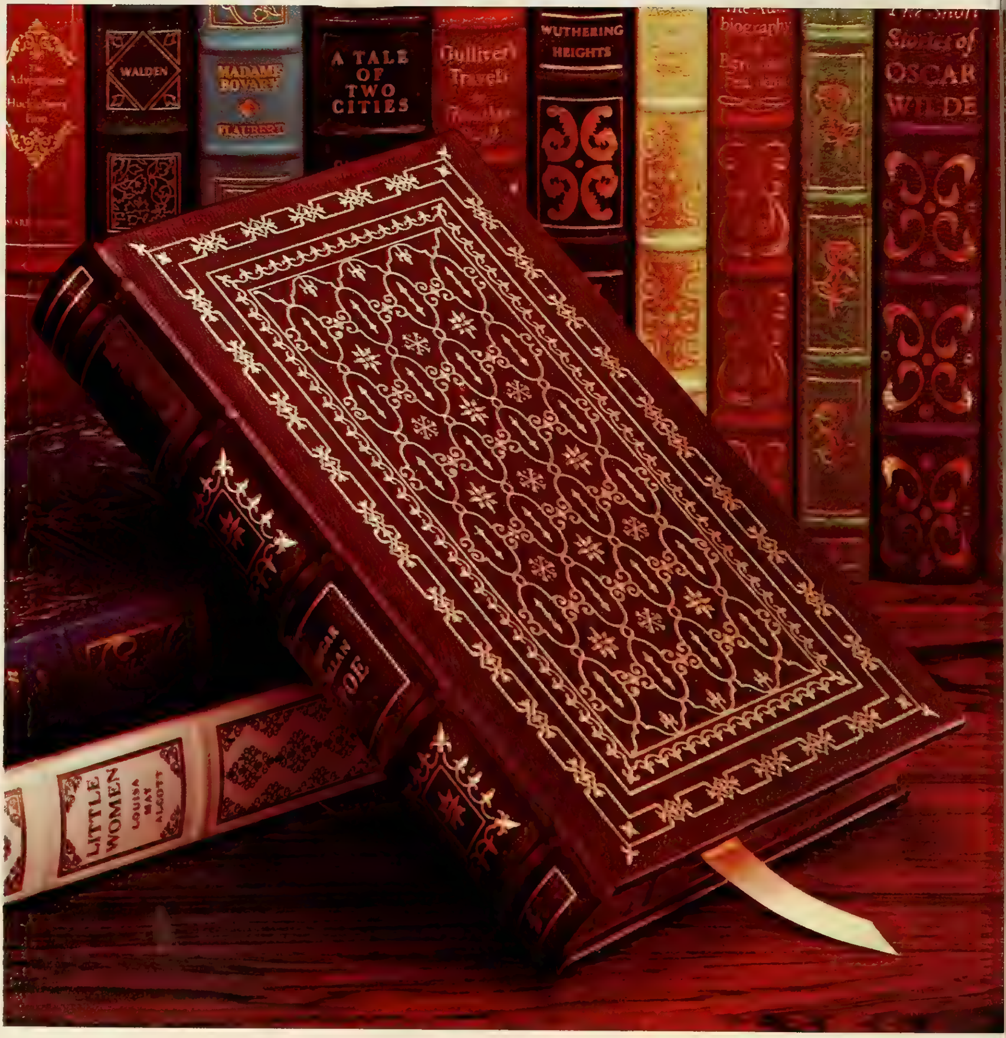
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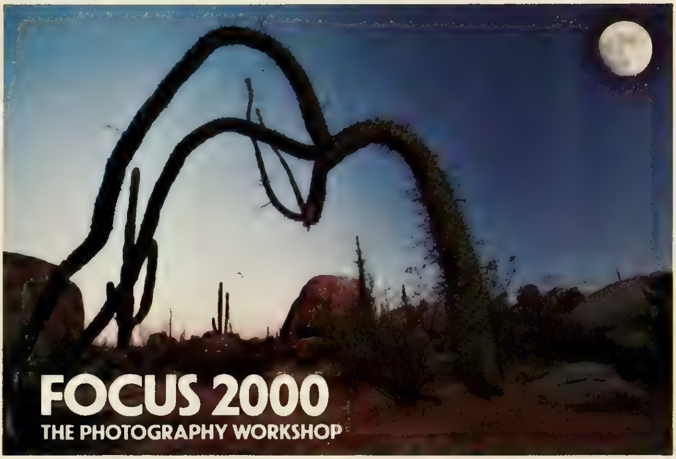

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It is obviously impossible to re late and supervise every acre of p lic land. It is possible to exam other industrialized nations of world, and learn from them.

PETER SEE
Beacon, N

Bechtol and Williams's conc over the amount of litter on Califor beaches and other recreational ar is shared by many in our country.

The major portion of this trash c sists of beverage bottles and cans, their research revealed. (A gla alongside most roads in the nat will reinforce this conclusion.)

I say "most roads" because h in Vermont a person is hard pres to find bottles or cans along ro sides, on the beaches, in the wo . . . anywhere.

This is a result of our beverage c tainer deposit law, which requi that a deposit be paid on soft dr and beer bottles and cans (usually f cents) and which is refunded wh the empty containers are returned.

"Flip-top" cans with metal ta that are removed to open the can prohibited.

This law has drastically reduc the amount of litter in our state.

Few people will throw away nickel, and for those who will, the are many more who will pick it u (Had they been Vermont bottl Bechtol and Williams's collecti would have brought a tidy $335.1

A. J. SHELV
Rutland, Verm

Every independent study I ha seen shows that metal beverage co tainers are distinctly in the minori as a percentage of litter. We are particularly happy about this as wish people wouldn't litter anythi at all. But banning the can will hard solve the problem.

While we don't have a ready a swer to the very real over-all litt problem, we are making exception progress in getting aluminum ca out of the litter. They are worth abo $400 a ton, and in 1976 alone the al minum industry recycled 4.9 billi of them, including about 1.5 billi from the state of California. A we'll do better in 1977!

BLAIR R. GETT
Aluminum Company of Ameri
Pittsburgh, Pennsylvan

INTRODUCING A MAGAZINE THAT HAS THE GUTS TO BE POSITIVE.

Citizen Kane would have told us we're crazy.

Because what people want to read about are the disasters and depravities of life.

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Quest 77 **LIFE NEVER CEASES TO AMAZE.**

The Biology of Aging

by Leonard Hayflick

Normal human cells seem to have a limited capacity for replication. Before the limit is reached, aging sets in and death approaches

There is probably no other area of scientific inquiry that abounds with as many untested or untestable theories as does the biology of aging. Three of the most tenable hypotheses on which most other theories ultimately rest are based on modern understanding of the molecular biology of genetics. Several considerations, not the least of which is the constancy of the life-span within each animal species, lead to the conclusion that the probable cause of senescent change is somehow contained in the genetic message.

The first of the three generalized possiblities now *au courant* is that the manifestations of senescent changes are the result of actions by the genetic program, which contains specific "aging genes" that code for the senile changes presaging the death of the organism. All developmental changes result from a preexisting genetic program played out over time. Consider, for instance, the inevitability of the menopause and the graying of hair, two examples of predictable biological events that occur late in life and that are probably genetically based.

Advocates of the theory of a prewritten genetic program conjecture that aging results from this kind of mechanism. They argue further that the survival of a species depends upon the ability of its members to live long enough to reach the age of procreation and that what occurs after that is essentially irrelevant. The biological changes that occur during this irrelevant period we recognize as senescence.

This reasoning postulates that profound clinical manifestations of aging occur only in humans and in their domestic or zoo animals. Wild animals that have not learned to cope with disease and predators do not live long enough to exhibit senescent changes to the degree observed in humans or those species we choose to protect. Old animals in the wild are simply culled by predators and disease well before real aging becomes manifest. Thus the profound senile changes seen in humans are inadvertently unmasked because of man's success in controlling his environment.

A second hypothesis involving the genetic apparatus has many of the features of the preceding argument, except that it does not include specific aging genes; instead, it proposes that the organism simply runs out of genetic information, resulting in those biological changes we recognize as senescence.

The third hypothesis of aging maintains that the genetic inform
tion system, although programmi
for sequential biological even
eventually acquires inaccuracies a
produces misspecified proteins. T
loss of accurate information occu
from an accumulation of rando
events that damage essential inform
tion-containing molecules. When
threshold of "hits," "damage
"insults," or "errors" is reache
normal biological activities stop a
signs of aging occur. The nature
damage to such essential molecul
is not clearly understood, but t
fact of its occurrence is known.

Some gerontologists believe th
the reason for the known redundan
of identical message units in hum
DNA, for example, is that it provid
insurance against the vulnerability
damage inherent in this system, a
that the presence of duplicated info
mation serves to lengthen the time b
fore hits and errors accumulate in su
ficient number to confound the g
netic message.

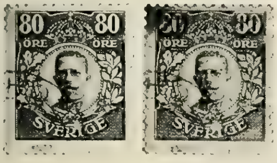
A specialized case of this last ge
eral theory has been described i
which errors are postulated to occ
in those molecules that synthesize e
zymes. A faulty enzyme could ve
quickly produce a batch of faulty
even lethal misspecified protein
very much as a single faulty machi
tool would quickly produce hundre
of faulty parts. A search for thes
misspecified proteins in aging cells

On Photographing the Invisible

To the naked eye, it was a Swedish 80-ore postage stamp. A rarity, and very valuable.

The camera, however, told quite another story. The stamp was a counterfeit.

Faint traces of tampering that were hidden to the naked eye were revealed by the camera. Someone, somewhere, had ingeniously altered the stamp by chemically removing a surprint. The stamp was worthless.



To the naked eye (left), the stamp was genuine. To the camera (right), it was a counterfeit. Note the faint, dark traces of tampering now revealed in the upper section.

What manner of exotic camera was this that could "see" the invisible?

The lens: one of the 20 in the Hasselblad arsenal, the 105mm Zeiss UV-Sonnar f4.3. Designed for photography within the ultraviolet portion of the electromagnetic spectrum, its costly quartz elements can detect radiations that are unseeable by the human eye.

It has peered at objects in outer space, examined forgeries, laid bare the secrets of counterfeit money. Not a lens for everyone, obviously, but an indication of just how awesomely comprehensive the Hasselblad System is.

The camera: an otherwise perfectly standard Hasselblad 500C/M, normally fitted with an 80mm Zeiss Planar f2.8 multi-coated lens.

This is the basic model that allows you to tap into the vast Hasselblad System. It is one of the most bewilderingly versatile cameras the world has ever known. Yet so marvelously simple to operate that it often plays the part of the family snapshot camera.

A True System.

The Hasselblad System is a prodigious array of 4 cameras, 20 lenses, 8 viewfinders, 9 film magazines, and over 300 other accessories. Choose the right pieces, and your 500C/M would be equipped for sports, aerial, architectural, and fashion photography.

And portrait, landscape, medical, underwater, and news photography.

And wildlife, laboratory, industrial, and child photography.

And you would always have the right film in the camera at the right time. You can shift from color to black-and-white and back again to color—and resume shooting at precisely the right frame—by popping in the protective dark slide and switching film backs.

The Camera with Nine Backs.

There is a small button on the film back of every Hasselblad 500C/M. Slide it sideways with your thumb and the back will come away in your hand.

The standard back holds 12 exposures. Each frame of film is 2¼ inches square, *almost four times the area of a 35mm frame.* (See box, below right, for actual size.)

This is only the beginning. There are eight other backs available: Backs that let you change to a 6 x 4.5cm format...or a 4.5 x 4.5cm superslide format for showing in any 35mm projector. Backs that give you a choice of 1, 12, 16, 24, 70, or 500 exposures. A back that is a sheet-film adapter. Even two backs for Polaroid film, so you can check composition, lighting, and exposure ahead of time.

You begin to realize why eight out of ten top commercial photographers surveyed name Hasselblad as the medium-format camera used in their work.

Retained Value vs. Obsolescence.

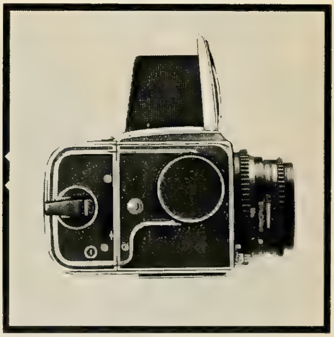
In an age when machines spew out cameras in the tens and hundreds of thousands, when flashy new models thrust last year's marvels into early obsolescence, Hasselblad goes its own way.

Planned obsolescence is taboo at Hasselblad. All but two of the accessories for the 500C/M will fit every Hasselblad made since 1957 (except the Super Wide C)...and will fit every future Hasselblad.

The greater part of a year is spent on building each camera, much of it crafted by hand. And fully one quarter of the work force devotes its time to nothing but quality control.

Little wonder, then, that a preowned Hasselblad commands such a high price...if its owner can be persuaded to part with it at all.

HASSELBLAD



The Hasselblad 500C/M.

A lavish brochure is available free if you write Braun North America, Dept 0000, 55 Cambridge Parkway, Cambridge Mass 02142 Braun North America is a division of The Gillette Company and exclusive marketer of Hasselblad cameras in the U.S.

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cramping you

If you think an economy car would put you in a compromising position, look again.

With a Volkswagen you could actually wind up with more room and comfort than you have now.

Our Dasher, for example, comes in a beautifully appointed 2-door hatchback or 4-door sedan, with fully reclining bucket seats, plush carpeting, and enough room for five passengers.

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Then there's our Rabbit, which has been catching everyone by surprise. Even Detroit.

To start with, it takes off like a shot. With acceleration from 0 to 50 mph i
amazing 7.7 seconds. (That's faster th
Triumph Spitfire.) And with front-w
drive that literally pulls you around cor
It also
more room

---

*Based on EPA Interior Volume Index measurement, published in the official 1977 EPA Guide 2nd E

dollars without style.

Scirocco

ole than 25 other cars you could
(including Monza, Mustang II, Pinto,
ta Celica, and Datsun B-210). And
e room for luggage than 53 other cars.
ld you believe, with the rear seat folded
n it can hold 21 bags of groceries. And
the seat folded up it still has more trunk
e than a Cadillac Seville.)
nally, we come to Scirocco, our true
ts car that gives you extravagance and
good sense at the same time.
st year Scirocco was the Trans Am
mp for cars under 2 liters. And speaking
yle, the Scirocco was just named one of
"25 best-designed factory-made prod-
available in America today" by Fortune
jazine.**
also gives you something few sports
can offer: room for four and more trunk
e than a Ford LTD II.
et (amazingly!) a Scirocco has the same
economy as a Rabbit.
oth Scirocco and Rabbit get
mpg on the highway and
npg in

the city. Dasher gets 36 mpg highway, 24 mpg city. (Of course, these are EPA estimates with standard transmissions. Your mileage may vary depending on how and where you drive, optional equipment and your car's condition.)

With all this going for our Volkswagens, we suggest you stop in to your Volkswagen dealer for a test sit.

It's one way to get through the energy crisis without getting bent out of shape.

Economy without sacrifice.

Dasher

une, May 1977.

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now the object of considerable research. Since no system works flawlessly, what causes these defects to occur initially? Is it chance or programming by aging genes, which, with clocklike precision, assures that the genetic program functions accurately up to a point and then specifies its ending?

Whether any of the aforementioned notions, alone or in combination, will ultimately explain the biology of senescence cannot now be determined. Nevertheless, most gerontologists would argue that the fundamental events that orchestrate age-related changes are likely to be found in the genetic machinery.

In addition to hypotheses rooted in genetic mechanisms, several theories of aging currently under study involve events occurring at a higher organizational level than the gene or enzyme. These theories include such things as immunological mechanisms, a mechanism based on the age-accelerating effect of radiation energy, and changes in the chemistry of connective tissues. Yet these latter considerations involve events occurring at levels of biological complexity that either do not apply to all animals that age or are secondary or tertiary changes caused by more fundamental events occurring at the gene level.

After reaching sexual maturity, individual members of a species eventually accumulate physiological losses that lead to an increase in their chances of dying. In fact, the actuarial data for humans, first analyzed by the English actuary Gompertz in 1825, reveal that the likelihood of dying doubles every seven years after the age of thirty. A variety of human physiological functions decline at a rate of about a 0.8 to 0.9 percent per year of the functional capacity present at age thirty.

The notion that aging occurs in animals that reach a fixed size after maturity is beyond dispute, but is the inevitability of the aging and death of individual cells composing that organism predetermined? A superficial consideration of this thought may provoke disbelief since it is intuitively obvious that a dead or aging organism must consist of dead or aging cells. Research shows that whatever causes aging and death in the whole organism does not produce similar changes, and at the same rate, in each cell composing the organism. If the rates of aging vary among organs, tissues, and their constituent cells, then one might argue that the root causes of aging may occur as a consequence of losses in some few cell types where the rate is fastest and the effects greatest. Let us explore the notion that normal somatic, or body, cells as opposed to germ, or sex, cells are predestined to undergo irreversible functional declines that may presage aging in the whole organism.

There are at least two ways in which this question has been tested. First, vertebrate cells have been grown and studied in cell culture, and second, cells have been serially transplanted in laboratory animals. The goals of such studies have been directed toward answering this fundamental question: Can vertebrate cells, functioning and replicating under ideal conditions, escape from the inevitability of aging and death, which is universally characteristic of the whole animals from which they were derived?

In respect to those studies undertaken in cell culture, one investigation stands out as the classic response to this intriguing question. In the early part of this century Alexis Carrel, a noted cell culturist, described experiments purporting to show that cells derived from chick heart tissue could divide indefinitely. The culture was voluntarily terminated after thirty-four years. This experiment is important to gerontologists because if cells, released from controls by the animal, can divide and function normally in culture for periods in excess of the life-span of the species, then either the type of cells cultured plays no role in the aging phenomenon or aging is the result of changes that occur only in whole organs. The inference would be that aging per se is not the result of events occurring in the cells.

Following Carrel's observation, support for his experiments seemed to be forthcoming from other laboratories in which it was noted that cultured cell populations, derived from many tissues of a variety of animal species and from humans, had the striking ability to replicate apparently indefinitely. These cell populations, which arise spontaneously, number in the hundreds and are best known by the prototype cell lines HeLa (derived from a human cervical carcinoma in 1951) and L cells (derived from mouse connective tissue in 1943). They continue to flourish to this day in cell culture laboratories throughout the world. Nevertheless, what seemed to be incontrovert
evidence for the potential immorta
of vertebrate cells soon fell be
new insights and a preponderanc
opposing evidence.

Of central importance to the qu
tion is whether the cell populati
studied *in vitro* are composed of r
mal or abnormal cells. Clearly
aging of animals occurs in normal
populations and if we are to equ
the behavior of normal cells *in v*
with similar cells *in vitro*, then
latter must also be shown to be n
mal.

It is for this reason that the "i
mortal" cell lines described above
which the HeLa and L cell popu
tions are prototypes, must be
cluded from consideration beca
they are abnormal cells. For examp
most immortal cell lines do not ha
either the exact number or the prec
morphology of chromosomes char
teristic of the cells composing the t
sue from which they originally
scended. Many such cell lines gi
rise to tumors when inoculated ir
laboratory animals, and some rev
biochemical properties unchara
teristic of the cells composing the t
sue of origin. The widespread use
these cell lines for a variety of
search purposes in laboratori
throughout the world is subject to t
criticism that, in most cases, they a
not characteristic of any cell ty
found in human or animal tissue.

However, cell populations entire
typical of normal cells found *in vi*
can be cultured, and in respect
gerontological inquiry, the findin
are profoundly different from the b
havior of abnormal cell lines.

Some fifteen years ago, Paul Moo
head, a geneticist now at the Unive
sity of Pennsylvania Medical Schoo
and I found that cultured norm
human embryonic cells underwent
finite number of population doublin
in vitro and then died. We found th
when such cells were grown under th
most favorable conditions, death wa
inevitable after about fifty populatio
doublings. We also showed that dea
of cultured normal cells was an inhe
ent property of the cells themselve
That observation has now been co
firmed in hundreds of laboratories.

Since normal cell strains have
limited doubling potential *in vitr*
studies on any single strain would b
severely curtailed were it not possibl
to preserve these cells at subzero ten
peratures for apparently indefinite pe
riods of time. The reconstitution

een human fetal cell strains has re-
led that, regardless of the dou-
ig level reached by the population
he time it is preserved, the total
nber of doublings that can be ex-
ted is about fifty when those made
ore and after preservation are
nbined. Storage of human cell
iins merely arrests the cells at a
ticular population doubling level
does not influence the total num-
of expected doublings.

s of this date, I have reconstituted
otal of 130 ampules of the human
l strain WI-38, which was placed
iquid nitrogen storage fifteen years
). Since 1962 one ampule has been
onstituted approximately each
nth, and all have yielded cell pop-
tions that have undergone about
y cumulative population dou-
ngs. This represents the longest pe-
d of time that viable normal human
ls have been arrested at subzero
nperatures.

We postulated that the finite life of
tured cells might represent aging
he cellular level. Although we and
ers were skeptical of this interpre-
ion at first, subsequent experi-
ntal data has tended to support this
a. However, before considering
newer developments in this field,
s necessary to reconsider Carrel's
icken cell experiment.

In the years following Carrel's ob-
vation, no one has been able to cul-
e chick cells serially in a state of
ntinuous, rapid proliferation longer
n one year. Thus, interpretation of
rrel's work is in serious doubt. It
likely that the method of prepara-
n of chick embryo extract,
epared daily under conditions of
w-speed centrifugation as a source
nutrients for his cultures, allowed
r the survival and introduction of
w, viable cells into the so-called
mortal culture at each feeding.

In 1965 I reported that all thirteen
man embryo lung cell popula-
ns that we studied reached senes-
nce after undergoing about fifty
pulation doublings. I also showed
at an average of twenty population
ublings occurred when human
lult cell populations were studied.
e age of the adult donors varied
om 26 to 87 and I was unable to find
precise correlation between the age
the adult donors and the number of
ll population doublings found. It
as clearly evident, however, that
man cell cultures derived from em-
yo donors as a group underwent
gnificantly more population dou-

Pruning as a means to more nearly perfect wines.

To us, pruning—the cutting off of parts of the grapevine during the winter dormant period—is the single most important practice in the entire culture of grapes.

It is a complex and highly judgmental operation that not only controls the amount of crop our vines will bear, but also controls the quality of the ultimate contribution that crop will make to our wines.

That is why, we do not consider a man thoroughly experienced until he has been pruning for at least three years.

Why We Prune

The whole purpose of pruning is to direct our vines to grow fewer but better grapes—grapes of optimum maturity and with the full potential of their variety.

Vines which produce too many grapes—a condition called overcropping—can lead to a thin, watery wine.

A carefully pruned vine will produce grapes that have acid and sugar contents in perfect balance, and their wine will be full-bodied, deep and brilliant in color, and with a bouquet that is true to the grape.

Our Unique Next Step

Sometimes, despite judicious pruning, a vine will overproduce anyway—perhaps because of optimum conditions for exceptional fruitfulness, or because it did not produce as much as it should have in the previous year.

In such a case, we resort to thinning.

Thinning involves the actual removal of whole grape clusters from the vine—the sacrificing of a part of our crop in order to ensure the quality of the rest.

Sometimes this can mean removing as much as one-third the crop from an overproducing vine in order to maintain vine vigor. Or all of it, if we wish to give the vine a rest to regain its vigor.

Gallo, we might point out, is one of the very few wineries to practice this costly technique of thinning in order to produce only the best possible wine grapes.

How We Prune

Pruning is basically an art. And over the years we have developed techniques that we believe provide the best possible results of that art.

We began researching and establishing our pruning practices in the 1940's.

At that time, every single variety of grape was given its own program to determine the best method of pruning for that particular vine.

As a result of our tests, we have established some general rules.

One, is that on each spur—that part of the new wood which remains after pruning—we never leave more than two buds for future growth. This ensures optimum grape quality.

We do, however, vary the number of spurs on each vine. This depends on the variety.

For example, the Chenin Blanc and Ruby Cabernet vines are allowed not more than twelve spurs, the French Colombard fourteen, and the Barbera ten.

In general, the varieties having larger grapes and grape clusters are left with fewer spurs so as not to tax them beyond their capacities, and the varieties having smaller grapes and grape clusters are left with more.

Who Prunes

Because so much depends on the judgment of our pruners—in addition to how much to cut, at what angle, and which wood—we treat their training very seriously.

At first, a beginner is only allowed to watch. Then he is permitted to work only when an experienced man is watching him. And finally, before working independently, he must work under a foreman.

That is why, as mentioned earlier, it is usually three years before we consider him a thoroughly experienced pruner.

Our Goal

Obviously, the reason we here at the Gallo Vineyards are so particular about pruning is the direct relationship it has with wine quality.

Our experience is that excellent wines can only be made from excellent grapes, and that perfect wines require perfect grapes.

Therefore, because our goal is to make the finest wines possible—to give you pleasure by bringing you only the fullest perfection of flavor, taste and bouquet—we are totally committed to growing and using only the best quality grapes.

That insistence on perfection, really, is the basic principle to which we have dedicated our wine-making lives.

Gallo Vineyards, Modesto, California

Fill out this coupon and save the children

Just by completing this simple questionnaire, you can befriend a needy child through Save the Children Federation. For only fifty-two cents a day, your money, combined with that of other sponsors, can breathe new life into an impoverished village... help hard-working people in their fight for dignity... turn despair into hope for a child who has known only disaster. Fifty-two cents may not buy much where you live. But for the poorest of the poor where the need is so desperate, it can work miracles.

NH 8/7

My Name is: ____________________

Address ____________________

City ____________ State ____________ Zip ____________

Tell us how you want to help, by answering these questions:

1. What geographical area are you interested in?

Urgent need exists in all the areas listed below. Select an area, or let us assign a child where the need is greatest.

☐ **Where the need is greatest**
☐ Appalachia (U.S.)
☐ Bangladesh
☐ Chicano (U.S.)
☐ Colombia
☐ Dominican Republic
☐ Honduras
☐ Indian (Latin America)
☐ Indian (U.S.)
☐ Indonesia
☐ Inner Cities (U.S.)
☐ Israel
☐ Korea
☐ Lebanon
☐ Mexico
☐ Rural South (U.S.)

2. Any sex or age preference?

If so, our personnel who are familiar with conditions in the area you have chosen will select a child in accordance with your wishes.

☐ Boy ☐ Girl ☐ No preference
Age ☐ 4 to 7 ☐ 8 to 12 ☐ No preference

3. Would you like a picture of your sponsored child?

Shortly after assignment is made, we can send you a photograph and brief personal history, if you desire.

☐ Yes ☐ No

4. Would you like to correspond with your sponsored child?

If desired, correspondence can help build a meaningful one-to-one relationship. Translations, where necessary, are supplied by Save the Children Federation.

☐ Yes ☐ No

5. Would you like information about the child's community?

Several times a year you can receive detailed reports on the activities and projects being undertaken in the community to benefit your sponsored child. These community reports show how your money is being used most effectively for permanent improvements to the child's environment—for health care, education, food production, nutrition, and community training. Would you like to receive such information?

☐ Yes ☐ No

6. How do you wish to send your payment?

☐ Monthly, $16 ☐ Semi-annually, $96
☐ Quarterly, $48 ☐ Annually, $192
Enclosed is my first payment: $________

7. Do you wish verification of Save the Children Federation credentials?

Save the Children is indeed proud of the handling of its funds. An exceptionally large percentage (78.1%) of each tax deductible dollar you donate is used for direct aid and supporting program services. Due to volunteered time, labor and materials, your donation provides your sponsored child with benefits worth many times your total gift. An informative annual report and audit statement are available upon request.

Annual Report ☐ Yes ☐ No
Audit Statement ☐ Yes ☐ No

8. Would you rather make a contribution than become a sponsor of an individual child at this time?

☐ Yes, enclosed is my contribution of $________
☐ Check here for general information about our unique programs for aiding impoverished children.

Mail to:

SAVE THE CHILDREN FEDERATION®
48 Wilton Road, Westport, Connecticut 06880

God bless you for caring enough!

Member of the International Union for Child Welfare and the American Council of Voluntary Agencies for Foreign Service.

YOUR SPONSORSHIP PAYMENTS AND CONTRIBUTIONS ARE U.S. INCOME TAX DEDUCTIBLE.

1977 SAVE THE CHILDREN FEDERATION, INC

blings (40 to 60) than those derived from adults as a group (10 to 30). More recently, others have not only confirmed my earlier report but have shown a direct correlation between donor age and the number of doublings cultured cells will undergo.

A phenomenon that is fundamental to our understanding of the biology of aging is that variations in life-spans between different species are far greater than individual differences within a given species. A fruit fly is ancient in 40 days, a mouse at 3 years, a horse at 30, a man at 100, and some tortoise species not until about 150 years.

Although the data are fragmentary, the population doubling potential of normal cells derived from the embryonic tissue of a variety of animal species seems to be proportional to the mean maximum life-span for those species. If such a correlation is ultimately proved, a significant finding will have been made. It would then be possible to determine the life-span for any animal species simply by assessing the number of population doublings of which their cultured normal embryonic cells are capable.

If the concept of the finite lifetime, or senescence, of cells grown *in vitro* is related to aging in the whole animal, then it will be most important to know whether normal cells have the capacity to proliferate indefinitely *in vivo*. If all of the multitude of animal cell types were continually renewed, without loss of function or capacity for self-renewal, we would expect that organs composed of such normal cells would function indefinitely and that their host would live on forever. Unhappily, however, renewal cell populations do not occur in most tissues and when they do, a finite limit to their proliferation occurs.

The important question is, Is it possible to circumvent the death of normal animal cells that results from the death of the "host" by serially transferring marked cells—that is, cells that can be distinguished from those of the host—to younger animals?

The question can be answered by serial transplantation of normal tissue to new, young animals each time the recipient approaches old age. Under these conditions would transplanted normal cells proliferate indefinitely? Data from four different laboratories in which mammary tissue, skin, and blood cells were employed indicate that these normal cells, serially transplanted to animals, do not survive indefinitely. It is well known that under similar conditions of tissue transplantation, cancer cell populations can be serially passed indefinitely. The implications may be that acquisition of the potential for unlimited cell division or escape from senescent changes by mammalian cells *in vitro* or *in vivo* can only be achieved by cells that have acquired some or all of the properties of cancer cells or germ (sex) cells. Paradoxically, this leads to the conclusion that for mammalian somatic cells to become biologically immortal they must first be induced to a cancerous state either *in vivo* or *in vitro*. They can then be subcultivated or transplanted indefinitely.

The possibility that animals age because one or more important cell populations lose their proliferative capacity is unlikely. I would suggest instead that normal cells have a finite capacity for replication and that this finite limit is rarely, if ever, reached by cells *in vivo* but is, of course, demonstrable *in vitro*. I would further suggest that other functional losses, which occur in cells prior to their loss of ability to divide, produce age changes in animals long before these normal cells have reached their maximum division limit. Indeed, we now know of many functional losses that take place in cultured normal human cells that are expressed well before the cells stop dividing. We believe that these decrements, which herald the approach of loss of division capacity, play a greater role in the expression of aging long before these cells fail to divide.

However, the measurement of loss of proliferative capacity is, after all, one of many cell functions that can be studied. If the manifestations of age changes are due to the loss of some cell function other than the loss of cell division, as I believe likely, then *in vitro* systems are all the more important as model systems. We must not forget that cell division itself is one of a number of functional losses that occur as normal cells proliferate *in vitro*.

The death of cells and the destruction of tissues and organs is a normal part of the developmental sequence in animals. It is the common method of eliminating organs and tissues that are useful only in the larval or embryonic stages of many organisms. Examples of such tissues are the primitive kidney of higher vertebrates, the tail and gills of tadpoles, larval insect
organs, and in many cases,
thymus. During the developmen
vertebrate limbs, cell death and
sorption shape the digits and thi
and upper-arm contours. In the lir
of vertebrates, cell "death clocl
operate on schedule. Loss of funct
leading to cell death is thus an inti
sic part of development.

The control of human aging has
cently gained much attention.
field is rife with suggestions. M
approaches are derived from anir
studies and are based on slowing
process down rather than circumve
ing it. Although some animal stud
have slowed aging, none of these
proaches has yet been tried in
mans. Animal studies that used
technique of reducing body tempe
ture showed that a reduction of o
a few degrees resulted in a signific
increase in the longevity of fruit fli
rotifers, and fish. In human being
is thought that a reduction in bo
temperature of two to three degre
Celsius would result in an extensi
of the life-span by approximate
twenty years.

Another approach involves the i
hibition of highly reactive molecul
known as free radicals. Their pre
ence, it is believed, may accelera
the process of aging. If so, the use
chemicals such as antioxidant
which bind free radicals and thus i
hibit their reactions, might ameliora
the aging phenomenon. Work
mice that have been fed antioxidan
has been interpreted as showing a
to 40 percent increase in mean lif
span.

Perhaps the most practical a
proach to increasing human longevi
might be based on experiments
which rats were underfed by provi
ing them with a very low caloric i
take. The result was a 50 percent i
crease in longevity. Similar resul
have been shown to occur in rotifer
silkworms, fruit flies, bees, chicken
and other animals. The effect, how
ever, is most pronounced if the lo
caloric diet is started when the an
mals are very young. This results i
a stretching out of the developmenta
program over a longer than norma
period of time. Infancy, puberty, ma
turity, adulthood, and aging simpl
occur at later than usual points, wit
no particular period seemingl
lengthened more than the others.
this approach should be practical fo
humans, the question would be
Which is more important, the quan
tity of life or its quality? □

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Hugh Downs interviews Robert E. Seymour, Chairman of the Board, Consolidated Natural Gas Co., and Chairman, American Gas Association.

HUGH DOWNS:

Last winter the U.S. experienced severe and disruptive shortages of natural gas. We are now officially in the middle of an energy crisis that President Carter has said requires waging the moral equivalent of war. Yet you have stated that you're optimistic about the future of gas energy.

ROBERT SEYMOUR:

I'm indeed optimistic. Let's look at the facts. Geological experts estimate that we have at least 35 and possibly as much as 60 years of supply from conventional sources, and that figure rises steeply when you add the gas from supplemental and non-conventional sources. So there is cause for optimism as far as the future of gas energy is concerned. Gas is certain to play a major role in the U.S. energy picture well into the 21st century. I consider that good news, because there is simply no other form of energy that could take over the load gas is carrying today.

HUGH DOWNS: **Just what is that load?**

ROBERT SEYMOUR:

Gas supplies over half of the energy users in the residential-commercial sector, and the largest share of energy consumed by industry. You get an even better perspective by looking at it this way: the gas industry supplies almost three times as much energy per year as the electric industry.

HUGH DOWNS:

That's something most people aren't aware of, I suspect.

ROBERT SEYMOUR:

I'm afraid you're right. President Carter has called natural gas our most precious fuel, and I suspect that in addition to its high-energy content his assessment was due to the fact that natural gas just doesn't pollute air, land, or water. Far from being *old-fashioned,* natural gas is really our most modern, most timely fuel.

HUGH DOWNS:

The critical question, it seems to me, is how does the cost of our "most precious," "most modern" fuel compare with other energy forms, let's say electricity?

ROBERT SEYMOUR:

In terms of energy bought by residential users, electricity

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	Gas Customers		Gas Consumption	
Types of Users	**Number**	**% of All Users by Market**	**Amount**	**% All Energy Consumed (by Market)**
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Industrial	180,000	44.5	11.7 quads*	57.3*
Gas Transmission & Distribution	—	—	0.6 quads	—
Total	**44,933,000**	—	**19.9 quads**	—

*Includes gas used for electric generation.

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This View of Life

by Stephen Jay Go

Our Allotted Lifetimes

During an average life, all mammals have nearly the same number of breaths and heartbeats

Meeting with Henry Ford in E. L. Doctorow's *Ragtime*, J. P. Morgan praises the assembly line as a faithful translation of nature's wisdom:

> Has it occurred to you that your assembly line is not merely a stroke of industrial genius but a projection of organic truth? After all, the interchangeability of parts is a rule of nature. . . . All mammals reproduce in the same way and share the same designs of self-nourishment, with digestive and circulatory systems that are recognizably the same, and they enjoy the same senses. . . . Shared design is what allows taxonomists to classify mammals as mammals.

An imperious tycoon should not be met with equivocation; nonetheless, I can only reply "yes, and no" to Morgan's pronouncement. Morgan was wrong if he thought that large mammals are geometric replicas of small ones. Elephants have relatively smaller brains and thicker legs than mice, and these differences record a general rule of mammalian design, not the idiosyncracies of particular animals.

Morgan was right in arguing that large animals are essentially similar to small members of their group. The similarity, however, does not lie in a constant shape. As I have argued in several columns, the basic laws of geometry dictate that animals must change their shape in order to perform the same function at different sizes. I remind readers of the classical example, first discussed by Galileo in 1638: the strength of an animal's leg is a function of its cross-sectional area (length × length); the weight that the leg must support varies as the animal's volume (length × length × length). If a mammal did not alter the relative thickness of its legs as it got larger, it would soon collapse si body weight would increase mu faster than the supporting strength limbs. Instead, large mammals ha relatively thicker leg bones than sm mammals. To remain the same function, animals must change th form.

The study of these changes in fo is called "scaling theory." Scali theory has uncovered a remarkab regularity of changing shape over t 25-millionfold range of mammali weight from shrew to blue whale. we plot brain weight versus bo weight for all mammals on the s called mouse-to-elephant (or shre to-whale) curve, very few species d viate far from a single line expressi the general rule: brain weight i creases only two-thirds as fast body weight as we move from sm to large mammals. (We share wi bottle-nosed dolphins the honor greatest deviance from the curve.)

We can often predict these reg larities from the physicial behavior objects. The heart, for example, is pump. Since all mammalian hea are similar in function, small hea will pump considerably faster th large ones (imagine how much fast you could work a finger-sized toy be lows than the giant model that fue a blacksmith's large forge). On t mouse-to-elephant curve for man mals, the length of a heartbeat i creases between one-fourth and on third as fast as body weight as w move from small to large mammal The generality of this conclusion h just been affirmed in an interestin study by J. E. Carrel and R. D Heathcote on the scaling of heart ra in spiders. They used a cool las beam to illuminate the hearts of res ing spiders and drew a crab spider-t tarantula curve for eighteen speci spanning nearly a thousandfold rang of body weight. Again, scaling very regular with heart rate increasin four-tenths as fast as body weigh

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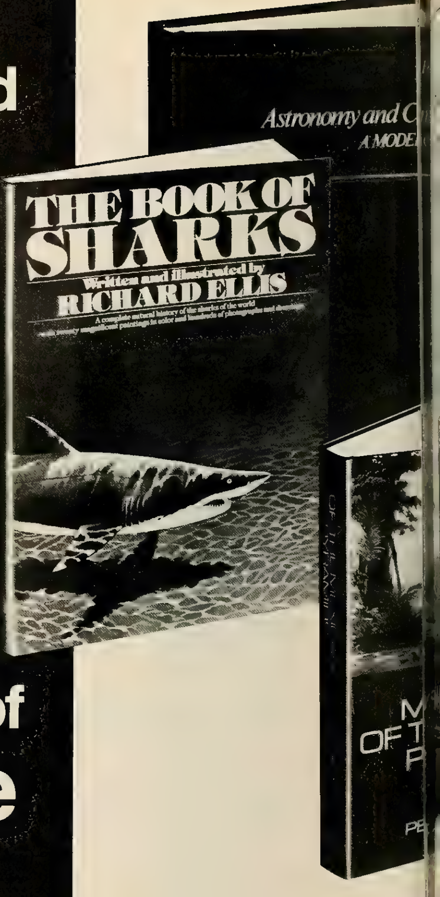

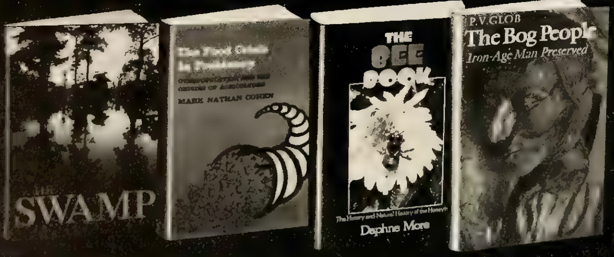

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We may extend this conclusion for hearts to a very general statement about the pace of life in small versus large animals. Small animals tick through life far more rapidly than large ones—their hearts work more quickly, they breathe more frequently, their pulse beats much faster. Most importantly, metabolic rate, the so-called fire of life, scales only three-fourths as fast as body weight in mammals. Large mammals generate much less heat per unit of body weight to keep themselves going. Tiny shrews move frenetically, eating nearly all their waking lives to keep their metabolic fire burning at its maximal rate among mammals; blue whales glide majestically, their hearts beating the slowest rhythm among active, warmblooded creatures.

If we consider the scaling of lifetime among mammals, an intriguing synthesis of these disparate data seems to suggest itself. We have all had enough experience with mammalian pets of various sizes to understand that small mammals tend to live for a shorter time than large ones. In fact, the scaling of mammalian lifetime follows a regular curve at about the same rate as heartbeat and breath time—between one-fourth and one-third as fast as body weight as we move from small to large animals. (Again, *Homo sapiens* emerges as a very peculiar animal. We live far longer than a mammal of our body size should. In previous columns, I have argued that humans evolved by a process called "neoteny"—the retention of shapes and growth rates that characterize juvenile stages of our primate ancestors. I also believe that neoteny is responsible for our elevated longevity. Compared with other mammals, all stages of human life—from juvenile features to adulthood—arise "too late." We are born as helpless embryos after a long gestation; we mature late after an extended childhood; we die, if fortune be kind, at ages otherwise reached only by the very largest warmblooded creatures.)

Usually, we pity the pet mouse or gerbil that lived its full span of a year or two at most. How brief its life, while we endure for the better part of a century. As the main theme of this column, I want to argue that such pity is misplaced (our personal grief, of course, is quite another matter; with this, science does not deal). J. P. Morgan of *Ragtime* was right—small and large mammals are essentially similar. Their lifetimes are scaled to their life's pace, and all endure for approximately the same amount of biological time. Small mammals tick fast, burn rapidly, and live for a short time; large ones live long at a stately pace. Measured by their own internal clocks, mammals of different sizes tend to live for the same amount of time.

Yet we are prevented from grasping this important and comforting concept by a deeply ingrained habit of Western thought. We are trained from earliest memory to regard absolute Newtonian time as the single valid measuring stick in a rational and objective world. We impose our kitchen clock, ticking equably, upon all things. We marvel at the quickness of a mouse, express boredom at the torpor of a hippopotamus. Yet each is living at the appropriate pace of its own biological clock.

I do not wish to deny the importance of absolute, astronomical time to organisms. Animals must measure it to lead successful lives. Deer must know when to regrow their antlers, birds when to migrate. Animals track the day–night cycle with their circadian rhythms; jet lag is the price we pay for moving much faster than nature intended. The bamboos of my April column somehow count 120 years before flowering again.

But absolute time is not the appropriate measuring stick for all biological phenomena. Consider the song of the humpback whale. These magnificent animals sing with such volume that their sounds travel through water for thousands of miles, perhaps even around the world, as their leading student Roger S. Payne has suggested. E. O. Wilson has described the awesome effect of these vocalizations: "The notes are eerie yet beautiful to the human ear. Deep basso groans and almost inaudibly high soprano squeaks alternate with repetitive squeals that suddenly rise or fall in pitch." We do not know the function of these songs. Perhaps they enable whales to find each other and to stay together during their annual transoceanic migrations.

Each whale has its own characteristic song; the highly complex patterns are repeated over and over again with great faithfulness. No scientific fact that I have learned in the last decade struck me with more force than Payne's report that the length of some songs may extend for more than
an hour. I have never been abl
memorize the five-minute first K
of the B-minor Mass (and not
want of trying); how could a w
sing for thirty minutes and then re
itself accurately? Of what poss
use is a thirty-minute repeat cycl
far too long for a human to recogn
we would never grasp it as a sir
song (without Payne's recording
chinery and much study after
fact). But then I remembered
whale's metabolic rate, the er
mously slow pace of its life compa
with ours. What do we know ab
a whale's perception of thirty m
utes? A humpback may scale
world to its own metabolic rate;
half-hour song may be our min
waltz. From any point of view,
song is spectacular; it is the most e
borate single display so far disc
ered in any animal. I merely urge
whale's point of view as an app
priate perspective.

We can provide some numeri
precision to support the claim that
mammals, on average, live for t
same amount of biological time. I
method developed by W. R. Stahl,
Gunther, and E. Guerra in the l
1950s and early 1960s, we search t
mouse-to-elephant equations for bi
logical properties that scale at t
same rate against body weight. F
example, Gunther and Guerra gi
the following equations for mamma
ian breath time and heartbeat tim
versus body weight.

$$\text{breath time} = .0000470\ \text{body}^{0.28}$$
$$\text{heartbeat time} = .0000119\ \text{body}^{0.28}$$

(Nonmathematical readers need n
be overwhelmed by the formalism
The equations simply mean that bo
breath time and heartbeat time i
crease about .28 times as fast as bod
weight as we move from small t
large mammals.) If we divide the tw
equations, body weight cancels o
because it is raised to the same powe

$$\frac{\text{breath time}}{\text{heartbeat time}} = \frac{.0000470\ \cancel{\text{body}^{0.28}}}{.0000119\ \cancel{\text{body}^{0.28}}} = 4.0$$

This says that the ratio of breath tim
to heartbeat time is 4.0 in mammal
of any body size. In other words, a
mammals, whatever their size
breathe once for each four heartbeats
Small animals breathe and beat the
hearts faster than large animals, bu
both breath and heart slow up at th
same relative rate as mammals ge
larger.

Lifetime also scales at the same e to body weight (.28 times as fast we move from small to large mam- ls). This means that the ratio of h breath time and heartbeat time lifetime is also constant over the ole range of mammalian size. en we perform an exercise similar that above, we find that all mam- ls, regardless of their size, tend to eathe about 200 million times dur- their lives (their hearts, therefore, at about 800 million times). Small mmals breathe fast, but live for a ort time. Measured by the sensible ernal clocks of their own hearts or e rhythm of their own breathing, all mmals live about the same time. stute readers, having counted their eaths, may have calculated that ey should have died long ago. But *omo sapiens* is a markedly deviant mmal in more ways than brain- ess alone. We live about three times long as mammals of our body size hould," but we breathe at the ight" rate and thus live to breathe out three times as much as an av- age mammal of our body size.)

The mayfly lives but a day as an ult. It may, for all I know, experi- ce that day as we live a lifetime. et all is not relative in our world, d such a short glimpse of it must vite distortion in interpreting events king on longer scales. In a brilliant etaphor, the pre-Darwinian evolu- onist Robert Chambers spoke of a ayfly watching the metamorphosis a tadpole into a frog (from *Vestiges the Natural History of Creation, 844)*:

> ıppose that an ephemeron [a mayfly], overing over a pool for its one April day life, were capable of observing the fry the frog in the waters below. In its aged ternoon, having seen no change upon em for such a long time, it would be ttle qualified to conceive that the exter- al branchiae [gills] of these creatures ere to decay, and be replaced by internal ngs, that feet were to be developed, the il erased, and the animal then to become denizen of the land.

Human consciousness arose but a inute before midnight on the geo- ogic clock. Yet we mayflies, igno- ant perhaps of the messages buried earth's long history, try to bend an ncient world to our purposes. Let us ope that we are still in the morning f our April day.

tephen Jay Gould teaches biology, eology, and the history of science at arvard University.

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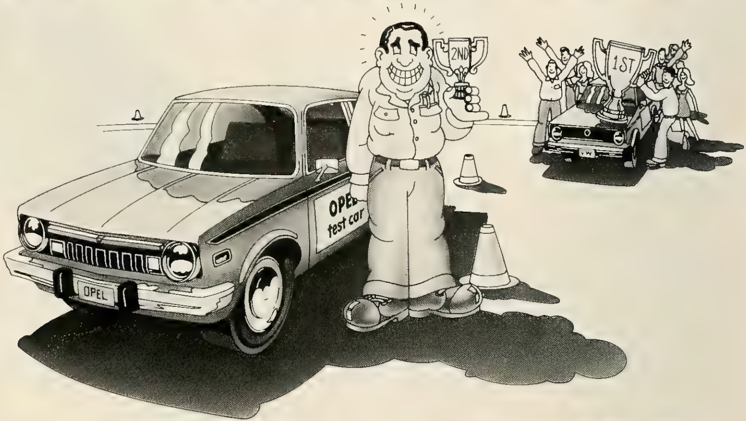
Opel makes news.



The results of the Buick Opel 5-Car Showdown are in!

Opel finishes...uh...2nd.

A lot of car makers compare their car to other cars.

We compared our car *with* other cars.

In a daring, fender-to-fender competition called The Buick Opel 5-Car Showdown. In it, we pitted our Opel against four better known competitors in point-by-point, side-by-side, independently supervised tests of acceleration, cornering flatness, parking-lot maneuverability, pulling power, gradability, and a few other areas. In short, some of the things you'd like to know when you go out to shop for a car.

It was a bold move. After all, what if we didn't win?

Well, to make a long story short—we didn't. When all the tests were completed and all the figures tallied up, Opel finished second, right behind VW Rabbit. You can imagine how thrilled we were. But look at it this way: in order to finish second overall, we had to beat Toyota Corolla, Datsun B-210, and Subaru DL in a number of instances. (And in some areas, we beat VW, too, as you'll see.)

Which is a victory. And not just a moral one.

You see, we know Opel is a little dynamo of a car. But apparently no one else did. Because it seemed that whenever anyone went out looking for a practical little import, they looked real hard at the other cars in the Showdown. But hardly ever at ours.

So we wanted to show that Opel could hold its own against its famous competitors. That it should definitely be considered when you wander out to shop.

In other words, we were confident Opel was good enough to take on this competition.

Opel announces 4-doors.

Then we went one step further. And made Opel good enough to take on your family. By offering you our new, just-introduced-in-this-country Opel 4-door Sedan.

After all, if you've got a family (or maybe some friends you like taking along on spirited spins around the countryside), you need to carefully examine a car's ins and outs. So we gave you two more.

Easy come. Easy go.

Final Test Results	VW Rabbit	Buick Opel	Toyota Corolla	Subaru DL	Datsun B-210
	(Showdown Point Summary)				
Interior Noise	5	5	5	5	5
EPA Interior Room Estimates	5	3	4	2	1
EPA Trunk Capacity Estimates	5	3	2	4	1
Pulling Power (30mph 3rd gear) (55mph 4th gear)	3	5	4	2	1
Parking Lot Maneuverability	3	5	4	2	1
EPA Mileage Estimates	3	2	4	4	5
Estimated Range	2	3	5	5	4
Maintenance Stops* (Recommended)	5	3	4	2	4
Acceleration (0-55mph, 20-35mph) (30-70mph)	5	4	3	2	1
Gradability*** (30mph 3rd gear) (55mph 4th gear)	5	4	3	3	2
Cornering Flatness**	4	5	3	4	5
Steering Quickness	5	5	5	4	5
Grand Total	50	47	46	39	35

*The less frequent the number of visits over 37,500 miles of normal driving, the higher the score. The number and type of inspections, adjustments and replacements would vary by visit.

**Based upon opinion that less lean is preferable to more lean

***Includes vehicle weight

In California, Opel placed second on an overall basis. Individual test results vary from those shown above

See your Buick Opel dealer for complete details

Opel makes sense.

You can learn a lot from a test drive.

Or even a test-sit.

That will let you experience our ody-contoured vinyl seats. Seats taiored for comfort and good lateral upport. With seatbacks that adjust.

It'll show you—in one quick glance—how easy it is to read Opel's well thought-out instrument panel, and reach Opel's well-placed controls.

And it will reveal (most abundantly) Opel's thick, standard pile carpeting (one more way this small car lives up to its Buick name). Perhaps even startle you with an amazing sight in small cars these days: a real glove compartment . . . that locks.

What you will most certainly notice first, though—if you happen to be sitting in the driver's seat of an Opel Deluxe Coupe—is that you're not just looking at a bunch of warning lights. But gauges. A tachometer right next to the speedometer. An oil-pressure gauge. An ammeter. An electric clock with a second hand. All standard. To let the enthusiast in you keep a close eye on the kind of response you're getting from that gutsy 1.8 litre dynamo under the hood.

But to really feel how Opel goes on the road, you should really feel it. On the road.

And, oh, what a feeling.

Opel performs.

Indeed it does. As the 5-Car Showdown will testify. First of all, in tests of cornering flatness and steering quickness, none of the competitors out-ran Opel. And in tests of acceleration and gradability, only the VW Rabbit (a car much-ballyhooed for its fuel-injected engine) was able to nose out our Opel for top honors.

Opel's strong showing in these areas isn't surprising when you consider its own accoutrements. Like the dynamic overhead-cam, 4-cylinder hemi engine. Four-coil-spring-suspension. Front stabilizer bar. Rear track bar. Floor-mounted, full-synchronized, short-throw, 4-speed manual transmission (with 5-speed and automatic available). Rack-and-pinion steering. And lots more.

Nevertheless, it still may surprise you. But then, up to this point, maybe you haven't considered Opel.

Maybe you should.

More than just mileage: range.

When you do consider Opel, you'll find it quite considerate of you. With EPA mileage estimates of 36 mpg on the highway and 23 mpg in the city. (The actual mileage you get will vary depending on the type of driving you do, your driving habits, your car's condition and available equipment. Estimates lower in California.) But don't stop there.

You won't have to. Because with Opel's 13.7-gallon gas tank (largest of any of the cars in the Showdown, by the way), its estimated range is about 350 miles.

(By the way, this range estimate is a function of both gas tank capacity and miles per gallon, and is based on multiplying the EPA combined estimate, which is 27 mpg, by gas tank capacity. Actual range may vary.)

The best news of all.

If by now our intrepid little Opel is beginning to sound like an intriguing proposition, let us suggest you hurry to your Buick Opel dealer for further consultation.

Not only will he give you a brochure with complete details on the 5-Car Showdown, he'll be happy to provide you with one of those revealing test-drives we mentioned.

And, of course, he'll show you how very affordable Opel is to buy.

Come on, now. Any car with this much going for it is at least worth considering, isn't it?

BUICK OPEL

Minolta by Minolta by Irving Penn.

Should you buy a good used camera? Ask three million users.

Behind every new Minolta SR-T, there's experience and know-how that have satisfied more than three million owners.

And to satisfy that many people, a camera has to do a lot of things right.

Let's take a look at what's behind the Minolta SR-T's popularity.

It's easy to use, for one thing. With Minolta's patented through-the-lens metering system, you get perfect exposures just by lining up two needles in the big, bright viewfinder.

Interchangeable lenses, for another. All Minolta SR-T models accept all of the nearly forty Rokkor-X and Celtic lenses made by Minolta. So you can get all kinds of photographs—from fisheye wide-angle shots to close-up pictures of faraway subjects with a super-telephoto lens–using just one camera.

And the lenses are easy to change, with the unique Minolta bayonet mount that requires only a quick turn to put a lens on or take one off.

Should you buy the good used camera? Yes. Especially now that it's easier to own one than ever before. For more information, see your photo dealer or write Minolta Corporation, 101 Williams Drive, Ramsey, N.J. 07446.

MINOLTA

More than three million people own a Minolta SR-T.

Prizewinning photographs from the 1977 Natural History Photographic Competition

The successful entrants in the 1977 *Natural History* hotographic Competition might have taken a cue from olette, the French novelist. Her great word was *egarde!* before the beauty disappears. This she learned om her mother, who could not comprehend city life, a ardenless existence. Our contestants wanted to apture and preserve what they saw in their gardens, but the end could only bear witness to the ephemeral haracter of the natural world. Like Colette, they ad to recognize that all things change onstantly and irrevocably. Of our winners' work, no icture illustrates the photographer's dilemma more owerfully than Martha Cooper's sequence.

A free-lance photographer who, thanks to a father ho owned a camera store, has been taking pictures ince nursery school, Cooper passed a Maryland farm very day en route to a temporary job in Baltimore. "I idn't conceive the series as a sequence—it evolved aturally. The first picture I shot just because the farm oked so picturesque; the subsequent ones because I was saddened by its transformation." She moved to New York, and a year later, returned briefly to Baltimore and recorded the former farm's subdivision into lots—an all-too-frequent event in nature.

Two prizewinners were similar examples of sharp eyes paired with feet heading elsewhere. Willard Colburn passed the young robins in their traffic-light nest—nature adapting reasonably well to technology—every day for two weeks. Finally, one Saturday morning, the sun broke through the Oregon rains, giving him enough light to photograph. Arthur Swoger, a professional who does every kind of work, especially nature photography, took the subway to Jamaica Bay Wildlife Sanctuary in New York City's borough of Queens. As he left the train, he spotted dozens of grasshoppers, ranging in color from pea green to deep brown, in a clump of tall grass alongside the station.

Sometimes, a photographer—as an apprentice in looking—must combine contemplation with careful planning, patience, and ingenuity. Karin Furlow had always found her two-year-old grandson's short, fat feet amusing, but to convey their charm, she had to persuade him to pose with a mirror. Dale Sarver, who is earning a Ph.D. in marine biology at the University of Hawaii, ran into unforeseen difficulties using a movie camera to photograph a snail devouring a sea cucumber—a minute-long process. The snail, which normally appears only at night, buried its head in the sand to avoid the floodlights. Using a still camera, Sarver needed extra film; the animal would stop eating when it saw the camera's flash.

To watch a caterpillar hatch from its egg and change into a giant moth with a ten-inch wingspan, Jack De Coningh, an industrial designer, built a breeding box and created an ecosystem in his New York City apartment, experimenting with half a dozen different species of moths and butterflies. The moth's metamorphosis took five months, and De Coningh had to stay up for twenty-eight hours to photograph the caterpillar spinning its cocoon. Born in Indonesia, where he discovered early that the natural world was "a constant source of interest, beauty, and mystery," he is especially pleased that his granddaughter's class of urban first-graders wants to visit his breeding boxes. His pictures are his means of passing on to the young his urgent concern about environmental destruction.

Microphotography may be the ultimate expression of the photographer's admiration for his subject, no matter

FIRST PRI
Microphotograp
Dried solution
DL-methionine, ferric sulpha
and wa.
Photographed at 160
Sharon Barnett Gey

how small, how overlooked. Since he discovered microphotography three years ago, Michael Siegel, a microbiologist, is prepared to take a second look at everything. "It's practically the only kind of photography I've done since." He found that certain crystals, when subjected to polarized light, will break into masses of color and design. His winning picture is of a melted sheet of polyethylene, normally used for plastic bags.

The possibilities of dirt—not the clarity of crystals—drew Sharon Geyer to microphotography. Five years ago, working as a darkroom technician on blood and liver cell research, she discovered, "Though dirt ruined microscopic slides for what I was really after, it can be beautiful in a purely esthetic sense. When I realized this, I decided to add my own dirt." Her prizewinner, which one judge wanted to title "Mother and Child," is a dried solution of DL-methionine, ferric sulfate, and water. "All of my slides are a witches' brew of chemicals, dust, lint, whatever, and a dissolvent such as water or benzene. Very unscientific. This slide was concocted almost a year earlier, a fairly normal length of drying time."

Other photographs did not require elaborate technology, but the photographers did have to be born watchers: vigilant, patient, philosophical about mistakes and missed opportunities. Charles Krebs, a school bus contractor, spent a week alone in the Everglades—"you can't take the family"—waiting for late afternoon sunlight and a female anhinga with the turquoise eye coloring peculiar to the breeding season. Richard Smith waited for a very early October morning to photograph his mysterious island in a northeast Minnesota lake. To describe the day, he sent us part of Sigurd F. Olson's *The Singing Wilderness:* "It was before dawn, that period of hush before the birds had begun to sing. The lake was breathing softly as in sleep; rising and falling, it seemed to me to absorb like a great sponge all the sounds of the earth. It was a time of quiet—no wind rustling the leaves, no lapping of the water, no calling of animals or birds."

At dawn on the other side of the world, about ten miles west of Shiraz, Iran, an energetic sales pitch allowed Carol Bier the fly-on-the-wall invisibility every documentary photographer seeks. Bier and her husband spent last year doing archeological research in Iran, traveling to and from ruins in the province of Fars. En route, they were able to spend time with pastoral nomads of the Qashgai confederation of tribes, at both their summer and winter encampments, and to observ the fall and spring migrations to and from the camps. In her photograph, the merchant squatting at left has come out from Shiraz, the provincial capital, to barte the cones of sugar before him for the migrants' goats, sheep, milk products, or coins. "The merchant and th family were so absorbed in bargaining and gossip that they were unaware of me."

Other winners were blessed with luck, what Stephe Diehl modestly called, "Just one of those rare mome of being in the right place at the right time with the right equipment." Diehl, whose luck carried over fro last year's contest, in which he won an honorable mention for his study of an apple leaf, took his delic picture of fall foliage practically holding its breath on hardwood trees in New York State's Adirondack Mountains. "My wife and I were overtaken by a viol storm. Rain and wind blasted the mountainsides. Photography impossible that Saturday. Next morning we awoke to find that the rain had changed to snow. The winter storm had passed leaving clinging snow o virtually everything."

William Holmes happened to be photographing in h garden when he saw a fly land on an orange poppy. The fly's alert profile reminded him of "a miniature B58 Hustler ready to take off." Lee Rentz is getting a master's degree at Utah State University in Cache Valley, an agricultural region where the clouds are particularly beautiful in May. "I often look at the sky, grab a camera, and go out into a storm. If the clouds are interesting or if rain is falling somewhere i the distance, chances are I can take some dramatic photographs." On this occasion, he was struck by the contrast between his wife's red shirt and grasses bending in eerie storm light.

Some winners took a serendipitous shot and were surprised to discover what they had. Michael Neff saw a coot on a Swiss lake, where a late afternoon sky and reflections from a nearby building produced a "psychedelic effect" he liked on the waves. But he considered the photograph, "the worst of the three pictures I sent you." Fred Darvill was hiking in early morning fog. "Both my small daughter and I stopped rest. She was one switchback ahead of me. Without much thought or planning, I snapped the one picture only and we went on. I really did not realize how goo the photograph was until it was returned or I certainly would have taken more."

Some lookers, perhaps the most enterprising, pay

attention in unexotic spots, settings that border on the banal. On a photography safari to Mount Kilimanjaro, Ted Schiffman found a Masai woman in a model tribal village maintained for tourists. Renato Caselli, a Mississippi farmer, liked the tail he saw on a hippo in the Jackson zoo. And Everett Johnson was killing time in the Frankfurt zoo, waiting for a plane home on a chilly October day, when he found the meerkats enjoying a heat lamp. There was no question about his prize; the animals' irresistibly corny quality made the judges laugh out loud.

Our three judges were struck by the high quality of the 400 slides and photographs winnowed for their viewing from 30,000 entries that arrived from all over the world. The 1977 finalists' virtue was so consistent that one judge said his choices could only be considered capricious. In the end, the three judges concurred amicably on which pictures belonged at the top of the heap.

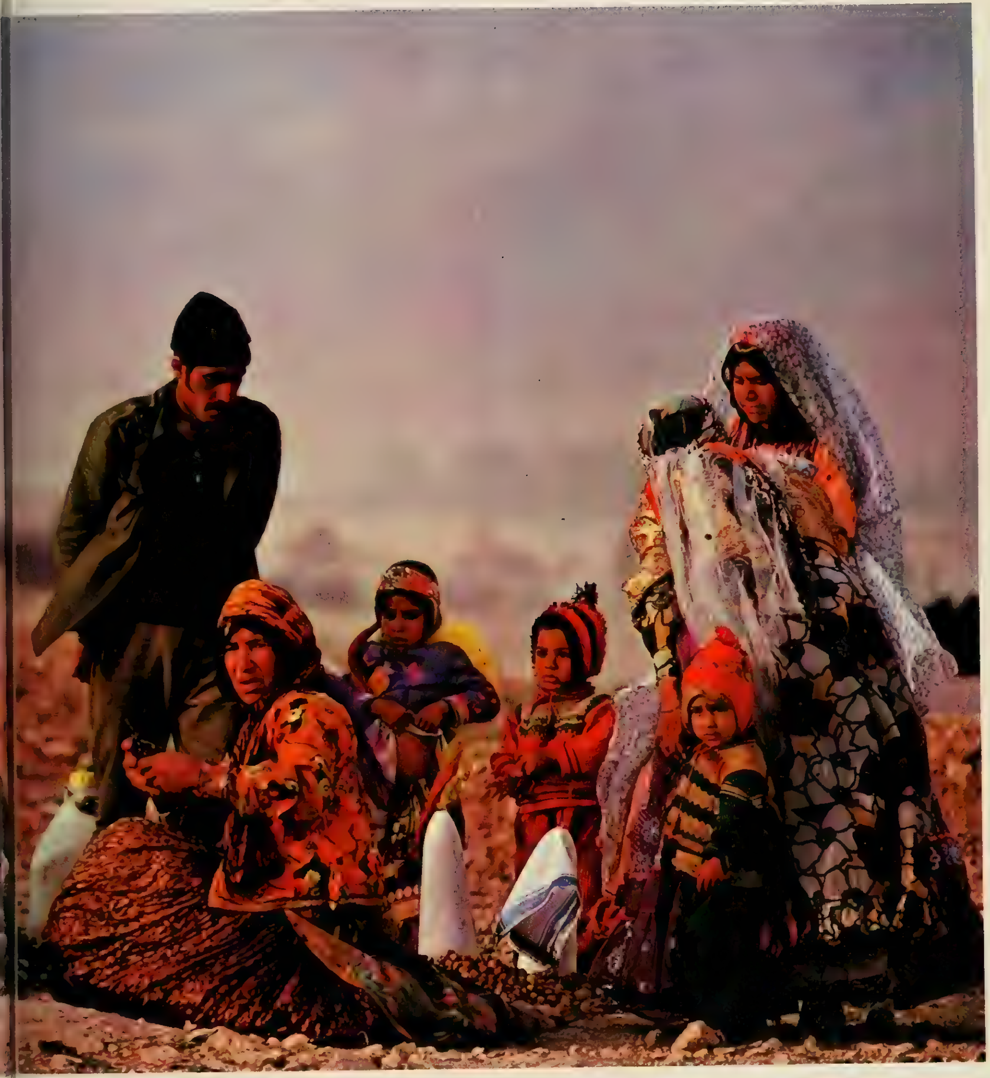
Although not all the judges had met previously, their careers had crossed or intersected. Milton Glaser, the influential graphic designer, is founder of Push Pin Studios and designer of *New York* magazine. John Dominis, now picture editor of *People* magazine, was formerly a staff photographer at *Life*, as was Ken Heyman, now a free-lancer. Some of Heyman's most familiar work appeared in the collection *"The Family of Man*. Working with Margaret Mead, he has illustrated two books: *Family,* published by Macmillan in 1965, and *World Enough: Rethinking the Future,* published by Little, Brown in 1975.

The 1977 Grand Prize was a round-trip for two to Peru. First Prize in each category was $500, Honorable Mention $100. Special awards—Humor in Nature, Urban Wildlife, and the Willoughby Prize, presented by Willoughby's Camera Stores—were each $200. All prizewinning photographs will be displayed in a special exhibition at the American Museum of Natural History in September 1977.

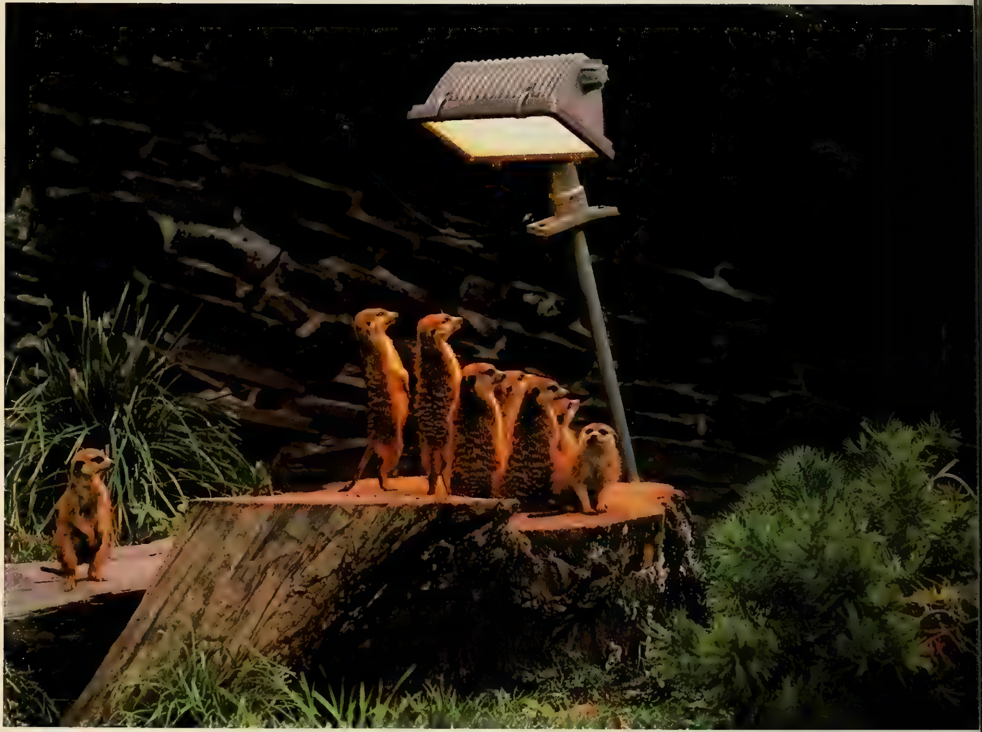
For the 1978 *Natural History* Photographic Competition, the categories will be: The Natural World; A Sequence of an Event in Nature; Macro/Microphotography (including pictures with a scanning electron microscope); and The Human Environment. There will be special awards for Humor in Nature and Urban Wildlife. Details concerning the rules, the prizes, and the deadlines will be announced early next year.

Ann Marie Cunningham

FIRST PRIZE
The Human Family
Qashqai nomads bartering
Fars Province, Iran
Carol Manson Bier



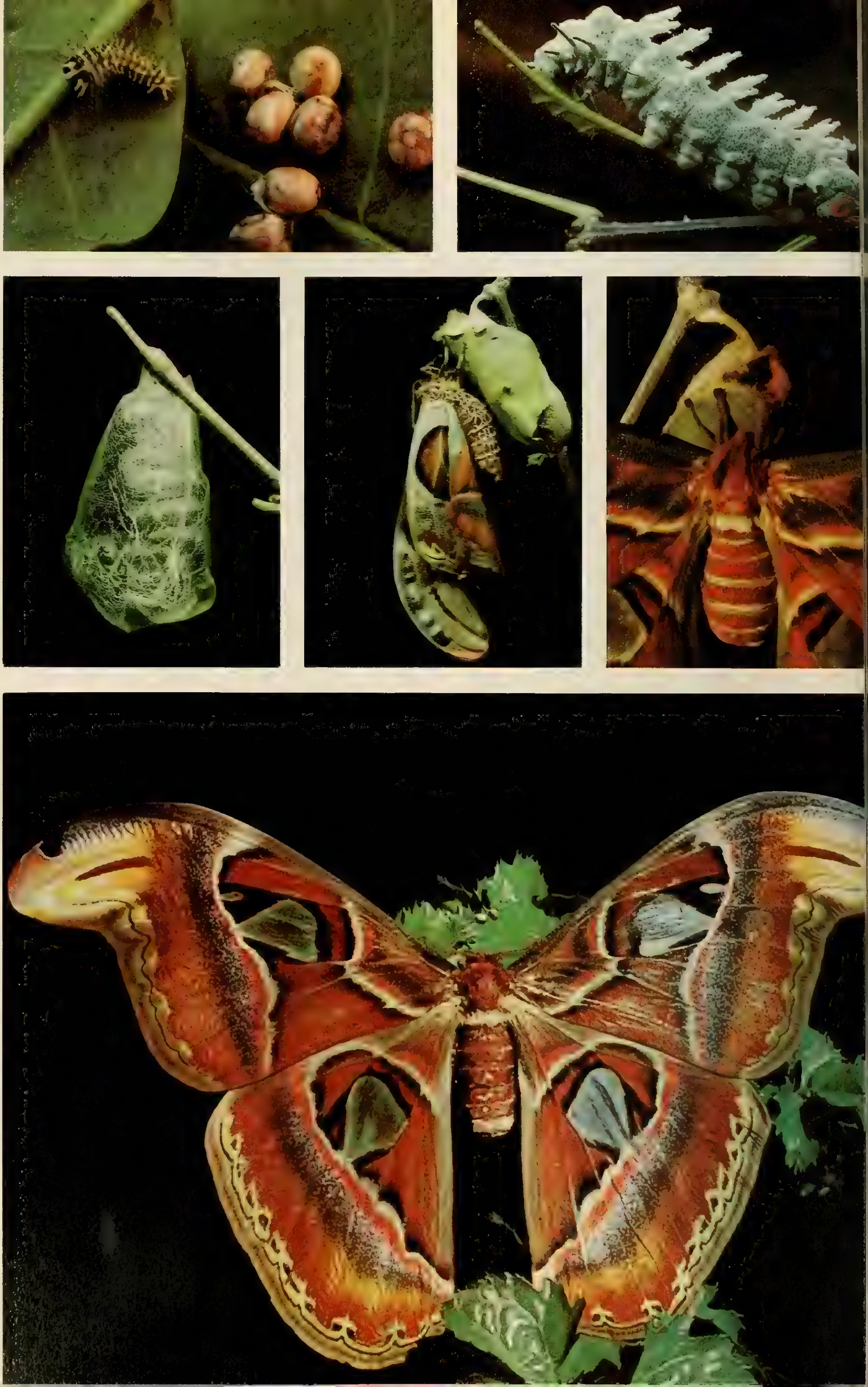
FIRST PRI
Urban Wildl
Stoplight Rob
Eugene, Oreg
Willard L. Colbu



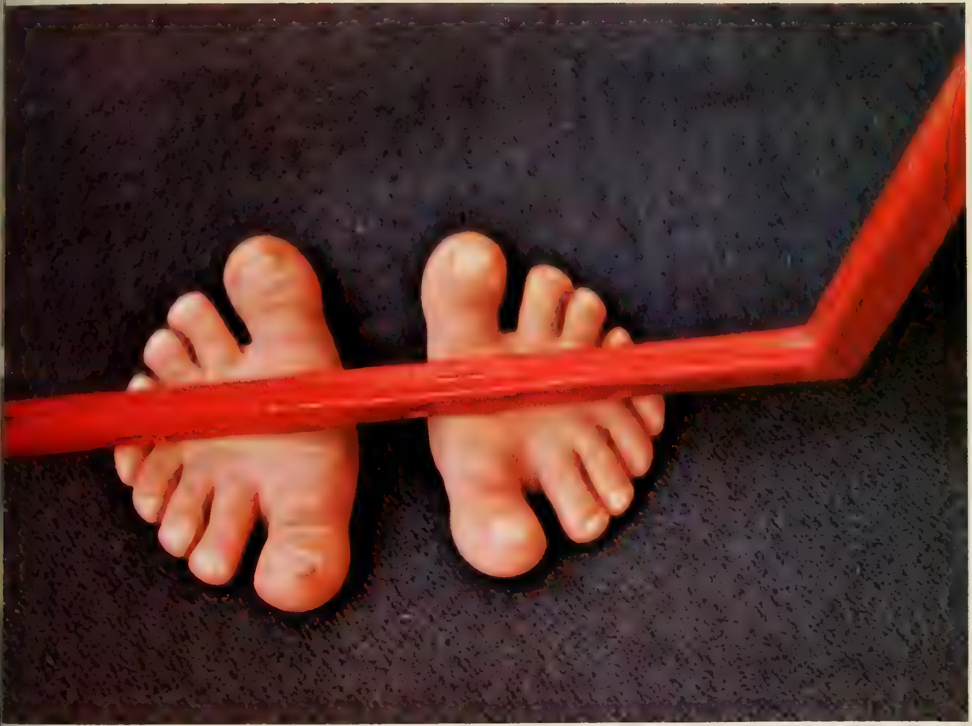
FIRST PRIZE
Humor in Nature
Meerkats
Frankfurt Zoo, West Germany
Everett C. Johnson

FIRST PRIZE
A Sequence of an Event in Nature
A farm is sold
Owings Mills, Maryland
Martha Cooper

OTS
OR SALE
Acre PLUS
ll JACK MARSTELLER
4-1143 987-1854

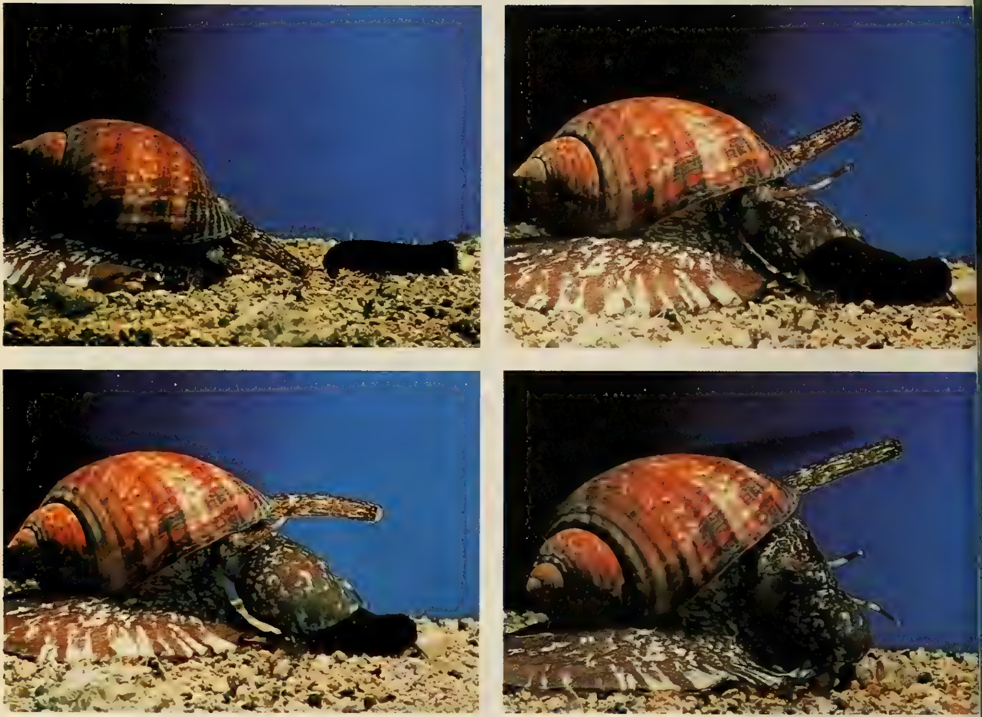


onorable Mention
etamorphosis of the giant moth
ew York, New York
ack DeConingh



SPECIAL AWARD
Willoughby Prize
Two-year-old boy's feet
San Jose, California
Karin J. Furlow

Honorable Menti
Sto
Cache Valley, Ut
Lee Ren

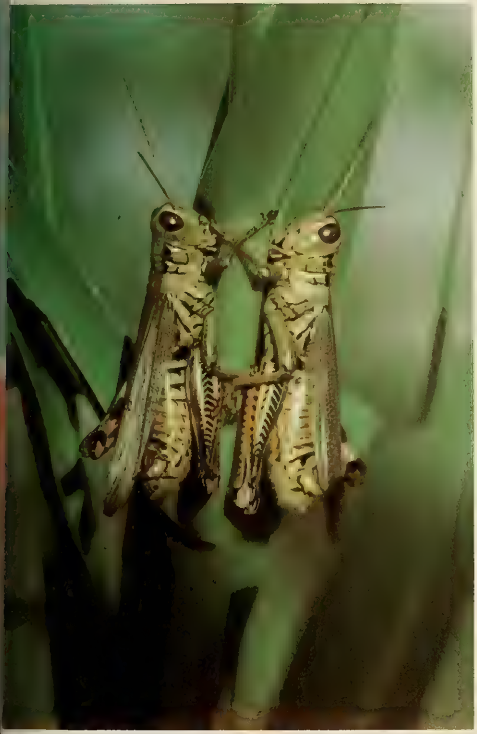


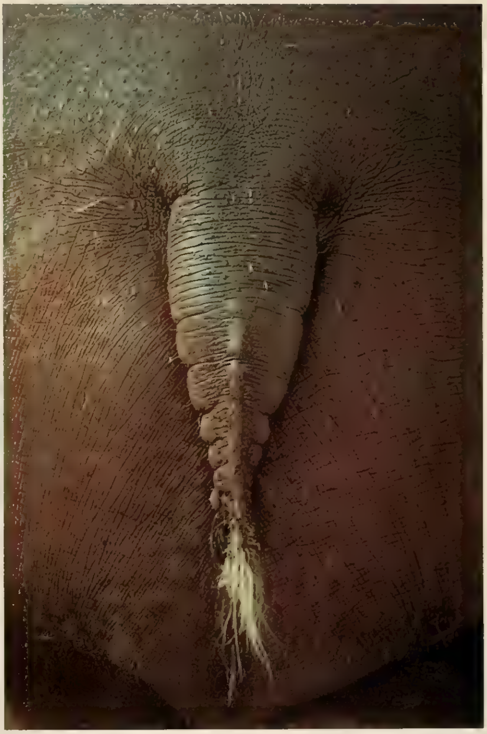
Honorable Mention
Snail devours a sea cucumber
Honolulu, Hawaii
Dale Sarver

Honorable Mention
Ford Island and reeds in mis
Burntside Lake, Minnesota
Richard Smith

onorable Mention
oot
ake Zurich, Switzerland
ichael C. Neff

Honorable Mention
Spur-throated grasshoppers
Queens, New York City
Arthur Swoger



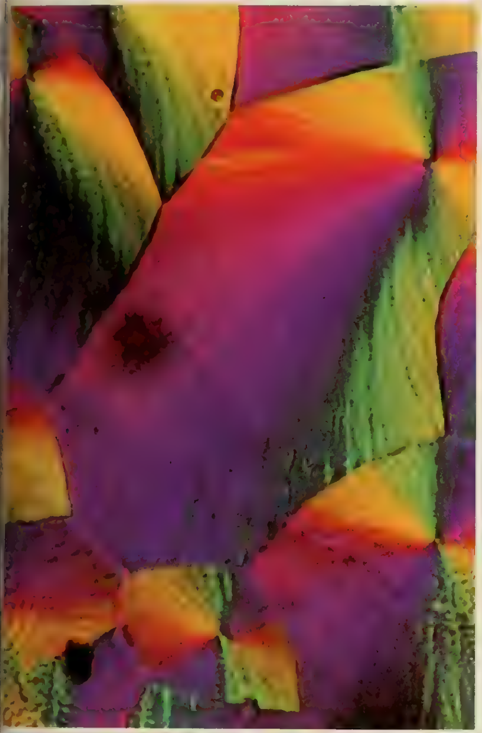


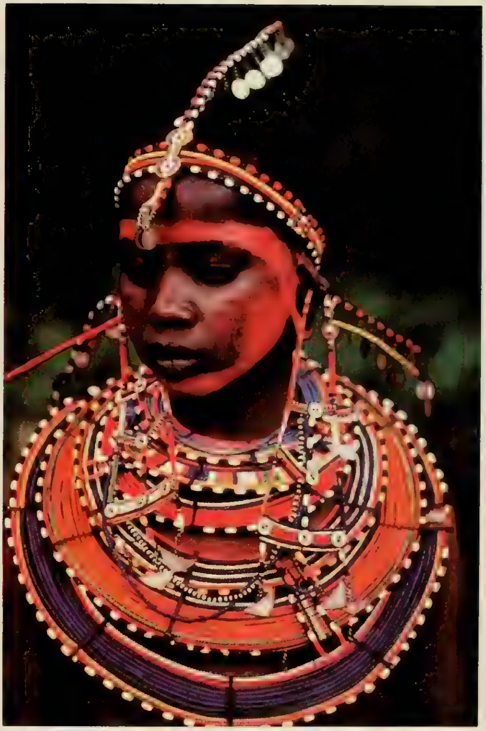
Honorable Mention
Hippopotamus tail
Zoo—Jackson, Mississippi
Renato Caselli

Honorable Mention
Fly on poppy
Toronto, Ohio
William A. Holmes

Honorable Mention
Snow on hardwood trees
Adirondack Mountains, New York
Stephen J. Diehl

Honorable Mention
Masai woman
Kenya
Ted Schiffman





Honorable Mention
Melted polyethylene sheet
Photographed at 400X
Michael Siegel

Overleaf
GRAND PRIZE
On the trail to Cascade Pass
North Cascades National Park, Washington
Fred T. Darvill, Jr.

Botanicas: Puerto Rican Folk Pharmacies

by Mary Ann Borrello and Elizabeth Mathias
photographs by Marcia Keegan

In New York City, small shops selling articulos religioso *are the only outward sign of Puerto Ricans' spiritist beliefs and practices.*

In New York City's Puerto Rican neighborhoods, life is very much the same as in Puerto Rico itself: the language is unchanged, and community institutions, such as bodegas, social clubs, and *botanicas,* or religious supply shops, are not very different. A *botanica*'s front window is usually a jumble of conventional gift store items, crucifixes, highly colored plaster statues of the Madonna, angels, and saints—including such foreign transplants as the Infant of Prague and the Italian favorites Saint Francis of Assisi and Saint Rocco—plus African gods, Buddhas, and cigar-store Indians. A passerby who peers beyond the statues or ventures inside the *botanica* will find shelves of yellow, white, red, black, and maroon candles and bead necklaces in similar colors; books on dream interpretation, Chinese proverbs, and numerology stacked alongside the Bible and Roman Catholic prayer books; jars of incense and herbs; bottles of Florida water, commercial toilet water, and herbal lotions; oils and soaps; aerosol sprays; lodestones and cowrie shells; Latin music tapes and records with saints on their covers and titles like "The Seven Powers" and "The Most Powerful Hand." Some *botanicas* stock various plants and such ani-

RELIGIOUS ARTICLES
HEALT
101

Left, in La Marqueta, *Spanish Harlem's open-air market, a stall offers beads, herbs, and lotions that promise good luck and health. Above, Otto Chicas is one of the market's largest* botanicas. *Flowers, used for home altars, are sold outside.*

OSTERIA

t far left, shrines at a spiritist entro, *or temple, include one Concilio Congo, an important frican deity. Worshipers have rought him Scotch, candy, fruit, owers, and banana leaves. Above, fifteen-year-old member of the* entro *congregation wears bead ecklaces in the favorite colors f her spiritist protectors.*

nals as turtles, pigeons, chickens.

The *botanica* is the economic manfestation—and to an outsider, the nly visible evidence—of the bifurated religious system of most Puerto icans, who since the 1950s have een settling in El Barrio, or Spanish arlem, New York's major Puerto ican neighborhood. Other pockets f settlement are found on Manhatan's West Side and Lower East Side; n parts of Brooklyn, the Bronx, and ueens; in nearby New Jersey and ong Island. Most Puerto Ricans are oman Catholics, but for many—reardless of income, social class, age, r education—orthodox religious affiliation pales beside their involvement with *espiritismo,* or spiritism. At *botanicas,* Puerto Ricans buy the formidable variety of objects and goods they need for spiritist observances. The *botanica*'s seemingly unrelated items all have symbolic meaning and order in the spiritist world view. And throngs of customers at flourishing *botanicas* attest to spiritism's thousands of followers.

To these faithful, daily life is surrounded by an invisible universe of good and evil spirits, with powers to affect the course of human affairs. Spiritist teaching consists of ways to contact the spirits, to enlist their aid or escape their ire. In Dan Wakefield's *Island in the City,* one of the first books about Puerto Rican culture in the urban United States, a Puerto Rican is quoted as saying, "If you ever talk to a Puerto Rican who says he doesn't believe in spirits, you know what that means? It means you haven't talked to him long enough." For an immigrant community under considerable stress, spiritism is a solace: it puts names on fears and supplies reasons why things go wrong. It also provides the possibility of relief or change if the unseen powers are courted by a person who has developed his or her *facultades,* the innate abilities to intercede with spirits.

In its Puerto Rican incarnation, spiritism is a mélange of Roman Catholicism, Yoruba religion brought to the Caribbean in the seventeenth century by African slaves from western Nigeria, and the teaching of Hippolyte Rival, a French spiritist philosopher who saw no conflict between spiritism and Scripture, and who published in the 1850s and 1860s under the name Allan Kardec. (Most *botanicas* carry Kardec's seven books, basic theology for any spiritist, as well as pictures of Kardec, which are used in spiritist centers or home shrines.) His fame seems to have reached Puerto Rico on publication, for séances were already being conducted at parties there in 1856.

Before Kardec arrived in book form, Puerto Ricans were already familiar with *santería,* a type of spiritism that exists throughout the Caribbean and Central and South America. In one of its forms, *santería* syncretizes Roman Catholicism with Yoruba religion. The Catholic clergy made strenuous efforts to convert slaves upon their arrival in the New World, but the Africans actually absorbed Catholicism into their own religion. They recognized their familiar gods and goddesses in the new figures of Christ, the Madonna, and the saints. Chango, for example, the most virile and sexual Yoruba deity, the warrior god who controls thunder, lightning, and fire, is syncretized with Saint Barbara, virgin martyr, protector of soldiers, whose father was struck by lightning after he beheaded her. Like all *santería* deities, Chango/Saint Barbara has a favorite color (red), claims certain animals and plants with magical and medicinal uses (sarsaparilla, among others), is invoked for particular reasons (protection against enemies), and responds favorably to favorite offerings (fruit, rum, and cigars). Oshun, the affectionate Yoruba goddess of rivers, love, and gold, is syncretized with La Caridad del Cobre, a Cuban virgin who watches over fishermen. Eleggua, Yoruba guardian of the highway and the home, is seen as Saint Anthony of Padua and the guardian angel. In the Puerto Rican community, members frequently

The centro*'s congregation celebrates its presiding madrina's anniversary as a medium and the birthday of one of her personal spirits. Dancing to the Afro-Cuban band, two teen-age girls, left and below, receive spirits and go into ecstatic trances. Below, a boy too young to go into trance watches.*

have special devotions to individual gods. Each saint must be venerated with amulets, oils, and lotions, as well as candles, bead necklaces, and incense in his or her favorite color, all purchasable at a *botanica*.

The *botanica*'s busiest day is Saturday, when crowds of customers, mostly women, line up. Each has a slip of white paper in hand and consults it frequently while making purchases. Friday evening is the night when most spiritist meetings are held in *centros,* or spiritist religious centers. In the spring of 1975, thanks to an invitation from a Puerto Rican student, we visited a *centro* in the Bronx, and observed how the intimate relationship between *botanicas* and the spiritist religion works.

This particular *centro* ceremony incorporated elements of both spiritism and *santería*. In this *centro,* the presiding medium was called *madrina,* which is a *santería* term. At most spiritist services, the leader is known as a medium. The ceremony was to begin at nine on a Friday night, but we arrived early to consult with the *madrina,* or medium. A medium has developed her *facultades* and has been trained in spiritist ritual by means of a long and expensive initiation, involving many *botanica* expenditures. She can communicate with the spirit world and can call spirits into her own body or those of the faithful. She can also see past, present, and future events in visions and hence can prescribe prayers and ceremonial rites to solve problems

The *centro* we visited was the presiding *madrina*'s home, an ordinar two-story frame house in a working class neighborhood. On the lawn near the *centro*'s basement entrance were two shrines, one enclosing statue of Saint Barbara, with fruit offerings at her feet. (*Santería* gods must be fed their favorite foods Many seem to have sweet teeth, prefering fruit and candy.) The othe niche held a statue of an America Indian chief, a protective figure representing a syncretism of spiritism an Indian healing lore. The statue wa bedecked with beaded necklaces i the god's colors to ward off evil, an its base was surrounded by fruit an cowrie shells and coconuts (used t foretell the future).

The *centro*'s sanctuary room measured about thirty by eighteen feet Folding chairs faced a free spac about the size of a small dance floor The room was dimly lit, and along th wall at the far end was a water fon filled with pennies and nickels meant by means of sympathetic magic, t attract more money. Behind the fon was a three-foot statue of La Carida del Cobre, with a boat at her feet. She wore yellow, Oshun's favorite color Large statues of other saints and African gods, accompanied by their favorite offerings, lined the walls of the room. To the font's right was a five-foot statue of Saint Barbara with a dish of fruit. Next to her stood a smaller statue of Saint Martin de Porres with a candy offering. Farther on was an open grass hut, a shrine to Concilio Congo, an African deity, whose offerings included the familiar coconut shells, strings of beads, and cowrie shells, as well as black dolls used for magical spells.

In the wall at the room's near end as a deep niche fronted by a glass ise, which doubled as a counter. ere was the *centro*'s *botanica,* run y the *madrina* to serve the more imediate needs of this particular relious community. Opposite, a door d to the *madrina*'s consulting room.

The few Hispanic men, women, nd children—women outnumbered en two to one—who had arrived rly for consultations or for socializg sat on folding chairs near the conlting room's entrance. A man wearg a white shirt and trousers came rward, and our student presented s. He was the *padrino,* the *marina*'s husband and assistant. He ld us in Spanish that the *madrina* would be with us shortly and would see us individually. For us, she would permit an exception to usual procedure: our student-interpreter could accompany each of us.

The *madrina,* a tall, light-brown-skinned woman in her late thirties, appeared and warmly encouraged us to come into her consulting room. Inside, the only uncluttered area was her sacred white table. The walls were decorated with scarves in colors associated with each god and saint, pictures of Chango, Yemaya, (goddess of the sea, syncretized with Our Lady of Regla, a Cuban madonna), Saint Lazarus (paired with Babalu-Aye, god of the sick), and Saint Barbara. Clustered on the floor were coconut shells, black dolls of several sizes, and roses of Jericho, curious dried plants that open and turn grayish green when placed in water. (*Santería*'s African roots give it animistic elements. As good luck plants, roses of Jericho are frequently fed honey or sugar water.)

The madrina *briefly ignites her hands and passes them before the faces of the faithful waiting to go into trance. Once in that state, they can depend on their friends to assist them.*

The madrina *opens* centro *ceremonies by welcoming the congregation. As spiritual leader of the* centro, *located in her basement, she is godmother to many of the attending faithful.*

The room smelled strongly of garlic, which had been burned to discourage evil spirits. A plate on a small stool contained the dollar bills left as payment by consultees who had preceded us.

The *madrina* indicated that each of us, in turn, should take a seat near her table. The first consultee was Elizabeth and after looking closely into her face for thirty seconds or so, the *madrina* turned to the table and took a handful of cowrie shells out of a drawer. She tossed the shells onto the table and, after studying the pattern they made, went into trance. In Spanish, she gave her evaluation of Elizabeth's personal life and problems. Then, coming out of trance, she spoke further about Elizabeth's particular problems and determined that her bad luck was the direct result of an evil spell that had been cast ten years before. A jealous person had stuck nails in an onion, tied it with black ribbon, and had buried it. (The ten-year-old spell the *madrina* envisioned coincided with a somewhat difficult period in Elizabeth's life.)

The *madrina* assured Elizabeth that with proper ritual, this old curse could be neutralized. Mary Anne was told that she had a strong spirit on her side, but that she had been a bit distracted and forgetful lately. For each of us, the *madrina* wrote on pieces of white paper lists of items we were to buy. Upon our return she would use our purchases to perform special rites to remove the evil influences plaguing our lives. Mary Anne's list included a white pigeon, forty-six pennies, four coconuts, a bottle of honey, Florida water for purification defense against evil, and four pieces of magnus rock. These lodestones, and nails or filings that have touched them, are thought to be alive and receive prayers and offerings.

Elizabeth's list was more complicated and expensive, calling for a black chicken, a white pigeon, Florida water, three coconuts, and four pieces of magnus rock. The *madrina* herself could supply the chicken and pigeons for a fee. A cording to our student, a chicken us ally costs $10, while a baby go sometimes needed for very serio problems, might run as high as $15

By 9:30 P.M. preparations f services had begun. We joined t congregation of about thirty peop and removed our shoes to avoid po luting the sacred area. The *madrin* *padrino,* and three helpers, a dressed in white, went to the alta Latin music, meant to draw spirit flooded the room. Moving with th music's tempo, the *madrina* and *padrino* ignited coconuts doused wi Florida water, and using their fee rolled the flaming spheres around th room to purify it. Members of th congregation then approached th altar one by one, and the *madrina* assisted each into trance by passing he flaming hands, which she had lit a she had the coconuts, before the ind vidual's face for a few seconds. Sh then turned the person around thre times, releasing him on the third turn whereupon helpers came forward t guide his movements. The tranc state lasts from a few seconds to several minutes, and may be mild to extremely agitated, depending on th type of spirit entering the person' body. Possessed faithful may fall t the floor in a frenzied state or spea in tongues.

Finally, after all who wished to g into trance—the majority of the congregation—had recovered and returned to their chairs, the *madrina*' turn arrived. This was the peak moment of the service. One by one, three spirits took possession of her, including her personal spirit, which had appeared to her in a dream or vision as the spirit of the saddle. When this spirit arrived, the *madrina* moved to the back of the room and placed her foot upon a saddle standing in a corner.

Of the three visiting spirits, one was aloof, avoiding contact with humans. Another, known to be a childlike and especially loving spirit, invited contact. To communicate with this spirit, the congregation, ourselves included, lined up in front of the *madrina,* who, whispering words of affection, embraced and presented each with a flower. The service ended about 1:00 A.M., when the *madrina,* exhausted by her activi-

s and by spirit possession, was led
ay by the *padrino* and two assist-
g mediums.

What we experienced at the *centro*
presents only one of the many
rieties of spiritist services. On Sat-
days, those who have consulted
ediums proceed to *botanicas* armed
ith shopping lists. However, since
ediums offer consultations at any
d all times, *botanica* business con-
ues steadily throughout the week.
me *botanicas* have their own small
nsulting room with a medium in at-
ndance, who may charge little or
thing. Clients are expected, however, to patronize the *botanica* after their sessions.

The *botanica* functions as a folk pharmacy, through which the medium ministers to the physical and spiritual health of the community. Faithful consult the medium for life's every problem—unemployment, ill health, marriage, love, and family difficulties—as well as dream interpretation and exorcism. Some health professionals recognize the medium's role as a folk psychotherapist: in the South Bronx, community mental health centers regularly refer Puerto Rican patients to mediums and *botanicas*, especially for psychosomatic complaints.

Although nothing—except perhaps the psychological influence—adequately explains how the medium's intervention works, we have seen many cases in which she has definitely helped. During one session at another *centro*, a woman complained of head pains. She had been X-rayed, but doctors had found no evidence of tumors. In this case, another member of the congregation, who had been developing his own *facultades*, had a vision of a woman whose head had been crushed by a car. The client exclaimed that her sister had died in such a manner. The group concluded that the dead woman's spirit was causing her sister's headaches and tried to communicate with the spirit to discover its motives. The medium and the client then proceeded with private consultations and ritual to drive away the spirit.

As spiritism's mediator, the medium provides channels, in private sessions and communal ritual, through which individuals may gain the protection, encouragement, and support of their fellows, as well as of spirits or saints and of deceased members of their own families. Through the medium's intervention, a congregation member can cast off evil and feel the presence of friendly spirits. The medium interprets and analyzes problems, provides explanations for personal misfortunes, and prescribes guaranteed remedies: rituals only she can perform or supplies available only at a *botanica*.

The remedies always cost money: *botanicas*, *botanica* wholesalers, and spiritism in general are big business in the Puerto Rican community. Spiritism's devout followers go to *bo-*

At the centro, *top, the madrina guides a group of young people learning to develop their* facultades, *abilities to communicate with spirits. Bottom, a flaming coconut, used to purify the* centro, *rolls past a shrine to Ellegua, guardian of entrances. The coconut will be kicked outdoors, extinguished, and smashed to ward off evil.*

tanicas not only to fill the medium's prescriptions but also to buy herbs (which purportedly can cure most ailments), and statues for home shrines, as well as various other supplies that honor personal gods, induce good luck for family and friends, or inflict bad luck on enemies. Statues can be considerable investments. In Spanish Harlem, we have seen five-foot plaster statues of Saint Barbara priced at $495. More modest statuary starts at $9.95. Two or three dollars buys lotions, soaps, and aerosol sprays with powers to remove jinxes, bless a house, attract a lover, bring luck in gambling, or invoke the Seven African Powers, a particularly potent group of *santería* deities.

As the medium is apt to prescribe Catholic prayers and attendance at Mass along with *santería* rituals, so *botanica* products call on African gods and Catholic saints and Jesus Christ. One label on a bottle of Seven African Powers lotion reads:

> Do you have problems? Call the Seven Saints to your aid. Humble yourself when you need assistance. Ask for help in the name of Jesus Christ with your problems, financial, health and love. These Seven African Powers will offer you concentration power.

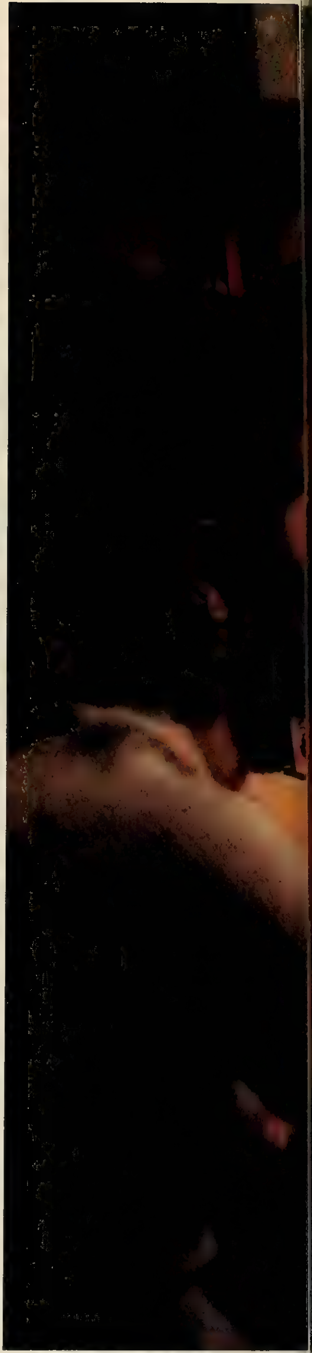
The same cross fertilization is obvious in the *botanica*'s stock of religious jewelry: Catholic medals and scapulars, spiritist amulets shaped like small rosary beads, or miniature black hands. When a Puerto Rican baby is baptized, the family will often ask the priest to bless the baby's medal and amulet, both worn on one chain. Some priests bless both objects without comment. Others attempt to convince the family that the bead or hand has no part in Catholicism. Puerto Ricans generally see little sense in this argument; they consider both objects necessary to protect the infant from evil.

Although candles are burned to honor the gods and achieve good health and happiness, they also have destructive uses. A woman who wants to destroy a marriage might buy three black candles, two shaped like nude females and one like a nude male. (Black, the most powerful color, may cause death; red will result in a lesser injury.) At home, she writes the names of the husband and wife she wants to separate on two slips of paper. If she wishes to become the man's new lover, she writes her own name on a third slip. She then turns two candles, representing a man and a woman, back to back, and places the husband's or wife's name under the appropriate figure. She puts her own name under the other female candle and places it facing the male. She lights all three candles and recites special prayers. Within the week to ten days the candles take to burn down, the marriage should be destroyed and the man attracted to his new lover.

Even smaller purchases like these candles represent considerable investments for people hampered by chronic shortages of cash. Nevertheless, the market for *botanicas* shows no signs of drying up. Besides serving as community therapy, spiritism also represents a colorful alternative to the relatively inexpressive Roman Catholic ceremonies. In and around the New York area, the traditional attitudes and beliefs of spiritism receive continual reinforcement from Puerto Rico. Followers take advantage of inexpensive weekend flights to migrate back and forth to their home island.

In New York, as in Puerto Rico, when crowds line up outside *botanicas* on Saturday mornings, they demonstrate that a minority subculture has managed to maintain a substantial level of ethnic and spiritual unity. Spiritism enriches the Puerto Rican's life by offering reasons for events that would otherwise go unexplained; within the spiritist community the disorders of daily life are ordered and made manageable. And the positive effects of this religion—its emphasis on loving concern among community members, shared problem solving, individual and group emotional security—are undeniable.

In the madrina*'s consulting room at the* centro, *a young woman asks guidance in a personal matter. The* madrina*'s advice will be based on the patterns she discerns in the cowrie shells before her. She also frequently uses these shells to predict the future.*



The Great Grizzly Grapple

hristopher Cauble

ational parks are for
ople, plants, and animals.
hen there is the big bear
at occasionally mauls people

Stoney Bear is dead. I knew her fore the National Park Service PS) killed her. Stoney was a griz- y bear in Mount McKinley National rk, Alaska, and we had met several nes, while I was ensconced in a car bus or while I was hiking alone. e never caused me any trouble; she ver harmed anyone; she never maged property.

Stoney was a wild, naturally forag- g grizzly, not a garbage-fed bear. e problem was that she was not raid of people, being far more toler- nt and unconcerned about human esence than any grizzly I had ever countered. She would feed by the adside even if a busload of tourists ere hanging out the windows, tak- g photographs, and yelling at her to ok up. The Eielson Visitor Center as within her territory, and she ould walk its sidewalks hunting the t ground squirrels that had become ow from tourist handouts and ignor- g bystanders only ten or twenty feet way.

Stoney Bear had been living in cKinley since 1972, always in the me roadside area and always alone. Because of repeated visits to the Eielson Center, she had been relocated by the National Park Service in 1974, but within two weeks she had returned across the crest of the Alaska Range, covering a distance of about sixty-five miles. In the spring of 1976 she was seen mating. Stoney had never given birth before. How dangerous and aggressive would she be with cubs? The prospect of a serious human injury resulting from Stoney's protective instinct and her habitual close contact with people became a crucial factor against her. The NPS considered relocating her again, but it was deemed too expensive. She had returned before, she might not survive in a new territory, and conceivably, the NPS could be held liable if Stoney caused trouble somewhere else. No nearby zoo wanted the bear. The final decision: kill her.

On June 14, 1976, Stoney Bear was injected with an overdose of Sernylan, a tranquilizer commonly used for large animals. She was destroyed atop Stoney Hill, her topographical namesake. She was killed, not for what she had done, but for what she might do. At the time of Stoney's death, the National Park Service was receiving both blame and blessing for its efforts at managing the grizzly bear.

Not long after Stoney's demise, National Park Service authorities were hunting proven killer grizzlies in Alaska and Montana. On September 12, 1976, a man was killed and eaten by a grizzly in Glacier Bay National Monument. The rogue bear was never found. On September 23, 1976, a young woman was dragged from her tent by a grizzly in Glacier National Park. Her body was found one hundred yards from the tent, and two grizzlies were shot when they charged rangers guarding the body. Three other persons were mauled last summer in Glacier National Park, and four persons were injured by grizzlies

Pao o Koch, Photo Researchers

n adult, free-ranging grizzly, ft, meanders through one of the any isolated, open reaches of ount McKinley National Park in laska. In Yellowstone National ark, right, grizzlies seeking od handouts are an increasingly ommon sight as the number of isitors to the park soars and the ears lose their fear of humans.

Bruce Coleman, Inc.

in Yellowstone National Park. People were charged and treed in Mount McKinley National Park and Katmai National Monument. In Canada a woman was killed and her companion severely mauled in Glacier National Park, British Columbia.

The grizzly bear, having previously been forced to retreat to the sanctuary of national parks, now faced another threat: the pressure from too many people within its last refuge, with a resultant danger for both people and bears.

The recent controversy over grizzly bears began on a hot August night in 1967 in Glacier National Park when, incredibly and inexplicably, two young women were killed on the same night by different grizzlies in separate backcountry areas. It was a night of bizarre horror, and the story appeared on the front pages of major newspapers and on television news broadcasts. A bitter and still-continuing debate erupted over whether or not grizzly bears should be allowed to exist in the national parks.

Normally a quiet bureaucracy, the National Park Service suddenly found itself inspected, dissected, and suspected as never before. When the public discovered that an open garbage dump close to a backcountry chalet and campground had been attracting grizzlies for years and that one of the women had been killed a sow grizzly visiting the dump, t NPS was charged with careless ma agement and branded a contributo villain in the death.

After the Glacier incidents, t personnel at other national par evaluated their bear situations to co rect dangerous practices, such operating open dumps. Yellowsto had several such dumps, and a though they were in backcount areas restricted from visitor trave the Glacier problem put pressure o Yellowstone to close its dumps to All agreed that the dumps should b closed, but disagreements over th best procedure to follow develope

Jen and Des Bartlett; Bruce Coleman, Inc.

ween the park service and two sci- ists who were involved in a ten- ar grizzly bear research project. hat resulted was an acrimonious bate known as the "great grizzly ntroversy."

The scientists, Frank and John aighead, argued for the gradual asing out of the dumps over a ten- ar period; concomitantly, the mpgrounds would be equipped th bear-proof garbage disposal sys- ns. They believed a rapid shut- wn of the dumps would put the gar- ge-addicted bears on a severe old turkey" regimen that would re- lt in grizzlies entering camp- unds in search of a garbage "fix."

More problem bears in campgrounds would translate into more dead bears since the NPS was under heavy pressure to protect visitors from grizzly-caused injury. This pressure dictated that the NPS act quickly to close the dumps.

The NPS was damned if it closed the dumps and damned if it didn't. In 1968 and 1969 the amount of edible garbage placed in the dumps was drastically reduced. Attempts to improve campground garbage facilities and park-wide disposal systems were also made. By the spring of 1971 all intrapark dumps had been closed. Sure enough, beginning in 1968, here came the bears.

From 1959 through 1967, 170 grizzlies, an annual average of 18.9, were removed from the entire Yellowstone ecosystem. This figure includes control activities by the NPS as well as hunting and control activities outside the park. From 1968 through 1972, 172 grizzlies, an annual average of 34.4, were removed. (Figures for the entire Yellowstone ecosystem are important because of the wide dispersal of garbage-feeding bears after the dump phase-out began in 1968.)

From 1968 through 1972, 51 grizzlies were removed by control actions from Yellowstone National Park itself, an annual average of 10.2 (33 were shot, 9 were donated to zoos, and 9 died from drug overdoses during capture operations). This compares with 37 grizzlies removed from 1959 through 1967, an annual average of 4.1.

The Craigheads and the NPS clashed repeatedly. The scientists warned of severe and possibly irrevocable population depletion. The NPS challenged the scientists' data and claimed that more bears existed in Yellowstone than they supposed. In some areas the data between the Craigheads and the NPS differed greatly, and the truth was lost in a wilderness of charges and rebuttals.

The Craigheads were no lightweights and the ensuing battle royal captured the interest of the national media. The great grizzly controversy soon enveloped scientists, bureaucrats, and conservation groups. Sec-

Shortly after emerging from hibernation, a grizzly, left, has a meal of water weeds. Tender plants, among the few available foods in early spring, help prepare the bear's digestive system for an omnivorous diet. Below, having its picture taken by an early season tourist, a young grizzly shows signs of habituation to humans.

Paolo Koch, Photo Researchers

Stephen J. Krasemann; Peter Arnold Photo Archives

Len Rue, Jr.; Bruce Coleman, Inc

bs of the year are playful,
l littermates spend much time
eracting with each other.
y diminishes as they get
er, a precursor of an adult's
ongly asocial behavior.

sow nurses her two cubs in an
en meadow. Many human–grizzly
cidents occur because female
ears, extremely defensive of
eir young, will attack anything
at seems to pose a threat.

ary of the Interior Rogers C.B. orton felt compelled to request the tional Academy of Sciences to er the debate as a nonpartisan lge.

The National Academy of Sciences ued its report in 1974, and neither e was entirely vindicated. The PS was criticized for its closed-door licy to independent research oups (the Craigheads had been shed out of their Yellowstone rearch laboratory in 1971) and its abby data collection methods. The aigheads were rebuked for their mputer models of the bear populan, which the Academy found to be rigid. The result of the report was agree that, yes, there was indeed controversy.

After 1972 the number of grizzlies quiring removal from Yellowstone ational Park dropped considerably. e park service crowed that its poly had worked; now Yellowstone's izzlies were wild, healthy, backuntry bears. The Craigheads reied that because there were so few izzlies left, the number of removals d to decrease.

Since 1971 the NPS has not permitd an independent census of Yellowone's grizzlies. Instead, the NPS s relied upon haphazard "sightgs" by observers with questionable alifications (mostly park employs) to derive a population estimate r the entire Yellowstone ecosystem between 319 and 364 bears for 74. The Craigheads, however, on the basis of their computer model, have projected a 1974 population of between 82 and 233, with 136 being "most probable." To further confuse the issue, an Interagency Grizzly Bear Study Team (led by an NPS biologist), mostly using previously collected data, made a sprawling estimate of anywhere from 237 to 540 grizzlies for 1974. In view of so many disparate estimates, the only possible conclusion is that no one really knows the current status of the grizzly population in the Yellowstone ecosystem.

What with the Glacier National Park deaths and the Yellowstone controversy, the park service entered a period of schizophrenia regarding bear management. Grizzly bears were to be preserved as a valuable wilderness feature, but tourists were to be protected from harm—and heaven forbid that park management should ever again contribute to a human injury. Perhaps for these reasons, bear management by the NPS took some very nasty turns. In 1972 a grizzly was trapped in a Mount McKinley National Park campground and hauled away to be relocated. The superintendent and chief ranger reported to the media, and even to other NPS employees, that the bear was simply transplanted to another section of the park. This was a deliberate lie. On orders of the superintendent, the bear was transplanted all right, directly into another dimension by a bullet in the brain. In 1974 a net-slung Yellowstone grizzly was being translocated via a helicopter; en route the net was opened and the bear dropped several hundred feet to smash on the ground. The NPS was between a rock and a hard place regarding bear management and the grizzly got the squeeze.

"The negligence of the defendant, United States of America, was the sole, direct and proximate cause of the death of Harry Eugene Walker on the night of June 24–25, 1972." With these words Judge A. Andrew Hauk, in an opinion filed in a U.S. District Court in March 1975, ordered $87,417.67 to be paid to members of the Walker family as the result of a suit filed after Walker had been killed by a grizzly bear near Old Faithful in Yellowstone National Park. The judge cited the park's dump-closure policy, as well as the failure to provide adequate warnings to park visitors about bear dangers, as contributory negligence. Claims by the NPS that Walker was knowingly and illegally camped in a closed area, that he deliberately avoided all opportunities to receive brochures warning of bears, that he was careless with his food and had garbage around his camp failed to move the judge. (It didn't help that the killer bear had been captured and relocated by the NPS two years earlier.)

The decision in the plaintiffs' favor caused repercussions throughout the park service. How much protection from wild bears could the NPS be expected to provide? If a hiker didn't receive one of the bear brochures and was mauled by a grizzly, would the NPS be negligently liable? Where was the line between reasonable visitor safety and excessive bear–people management?

Although the Walker decision was overturned in December 1976 on the basis of a technical exemption to the Federal Tort Claims Act, another suit has been filed by a man who was mauled by a grizzly in Glacier National Park in 1975. Thus the implication of the Walker case remains a Damoclean threat to the NPS.

While drownings, mountaineering mishaps, automobile wrecks, and a variety of other accidents occur in the parks, none seem as likely to be viewed as NPS negligence as grizzly injuries. The reverberations of Judge Hauk's gavel plucked at the nerves of NPS officials, and everyone prayed for no more incidents. The bureaucratic boat was rocking in the storm and the passengers were frantic.

At the orientation for seasonal employees in McKinley in the spring of 1975, the superintendent handed out copies of the Walker decision and said, "Here's what we're up against." Later in the summer, following an incident in which a bear bit a hiker, a permanant ranger first explained, "It wasn't really a mauling." An acute sensitivity to bear incidents developed, including a jargon of euphemisms reminiscent of the war reports from Vietnam. Bears were not killed, they were "dispatched" or, more blandly, "removed from the population." Bears were not threatening life and limb when they charged someone, they were "acting playfully toward hikers by chasing them." (The latter from a memorandum to be read at all interpretive programs after a pair of grizzlies treed a hiker in McKinley, in August 1974.)

After the deaths in Glacier Bay National Monument and Glacier National Park in 1976, the NPS quickly documented the details of each incident as never before. In the event there were any resultant lawsuits, the NPS wanted to be ready with all the facts.

Glacier National Park is a study in the growing problems between people and bears. Within its 1,580 square miles live some 200 grizzlies or about one bear for every eight square miles. In 1976 a record number of 1,662,678 tourists visited the park, an increase of 5.8 percent over 1975. The recorded overnight backcountry usage totaled 28,978 camper days. Although there are no statistics available for day-use of the backcountry, it can be safely assumed that such use, whether to hike, fish, climb, bird watch, or whatever, is also on the rise.

The number of grizzly bear incidents has been increasing in Glacier. In 1975 five persons were injured by the bears; in 1976 three persons were injured and another killed. Incidents of grizzlies charging people in the backcountry have correspondingly increased. During this period the grizzly population remained fairly stable but the number of tourists continued to rise. The figures suggest a simple equation: more people equal more injuries.

The answer to why this is happening is not an apparently simple correlation of numbers, however; there is an ominous belief that bear behavior may be changing. Attacks precipitated by some obvious provocation, such as a sow with cubs charging after being surprised, are expected incidents. An increase in this type of attack may be statistically predictable as human traffic increases. But incidents in 1975 and 1976 do not quite fit as attacks of provocation, and the bears involved were mainly solitary and/or younger animals.

In August 1975, a father and his two children were hiking along a popular trail to Grinnell Glacier. They made a turn and met a lone grizzly. The bruin charged and mauled all three persons before running off. The hikers were not carrying food and they had not harassed the animal. In September 1976, two people were hiking on a remote trail but making a considerable amount of noise when they saw a single grizzly. The bear mauled both of them. The NPS has labeled this attack as "unprovoked." Later in September a grizzly dragged a woman from her tent at the Many Glacier Campground and killed her. The campsite was clean and free of food. A park service board of inquiry could find no reason for the attack.

Clifford J. Martinka, Glacier National Park's supervisory research biologist, is a bear authority. He well knows the grizzly bear situation in Glacier, and he is worried: "I used to think that with prudent management we could largely eliminate bear–human incidents. Now I'm not so sure. I'm beginning to believe the grizzlies have reached the point where they have encountered so many people that it has affected their collective behavior. They may be losing their shyness of humans but not losing their aggressiveness. It might be they are becoming behaviorally more like black bears, which are now very bold around people. If grizzlies get as bold as blacks it could be critical because grizzlies are altogether a more aggressive and dangerous animal."

Hunted bears may be more afraid of humans than are sanctuary-protected bears and less of a threat to campers and hikers. In the Bob Marshall Wilderness Area south of Glacier National Park, grizzlies have been hunted for years and there is seldom an aggressive action toward humans. The bears have learned to avoid humans and their "thunder sticks." In national parks, however, hunting is quite incompatible with the guiding philosophy.

Experiments are now being conducted into such adverse conditioning techniques as the use of lights, chemicals, and noise to encourage bears to avoid people. These are still in the testing stage, however, and research is slow and difficult. What might work with a caged bear may produce different results with wild grizzlies. Also, finding areas where experiments can be conducted without endangering bystanders is of
frustrating.

Trying to physically separate p
ple and bears is a common mana
ment method. In Glacier, for
ample, a bear-monitoring system c
lects sightings of grizzlies and repo
of bear trouble and examines them
determine if particular trails a
campgrounds should be closed.
1976 more trails were temporar
closed than ever before. Cons
eration is also being given to buildi
a compound-type campground at o
backcountry site. Certain roadsi
campgrounds may be restricted
hard-side camping only, thereby pr
hibiting tents and allowing only tra
ers, truck campers, and motor home

The argument that parks are f
people, not for bears, is heard aft
every grizzly bear incident, usual
from people using such incidents
springboards for their own wishes.

A variation of this premise is e
countered, notably in Alaska, wh
people condemn the NPS policy ba
ning firearms in the national park
After the Glacier Bay incident la
September, an outdoor writer for t
Anchorage Daily Times blasted t
no-gun policy and stated that
would not camp in prime grizz
country, national parks include
without some sort of weapon, adhe
ing to the belief that breaking the la
is preferable to being chewed on b
a bear.

Basically the no-firearm policy
meant to protect wildlife from unne
essary slaughter. Without it, poach
ing would be far more difficult to co
trol, and in the vast areas of Alaska
parks there would be no way the NP
could prevent the indiscriminat
shooting of any animal. Specificall
regarding bears, any appearance of
grizzly can be frightening to the inex
perienced and unprepared. The NP
fears that many people would shoo
without real need. Also, if the park
became littered with bears wounde
by poor or indiscriminate shooting
the danger of bear attacks would b
astronomically greater.

The NPS is not contemplating th
extirpation of grizzlies, although
segment of the public favors such
policy. While bear attacks are dra
matic and nerve chilling, other acci
dents account for far more tragedie
in the national parks. In records dat

back to 1913, 3 persons have been ed by grizzlies in Glacier National k while 69 have perished from er outdoor accidents, such as wnings (36), falls while hiking), or being hit by falling objects h as rocks and trees (6). Consid- ng that only 3 out of 1,600,000 vis- s to Glacier in 1976 were harmed grizzlies, the risk of a bear attack xceedingly remote. Nonetheless, rs form a large area of concern in visitor's mind, and their presence ects human attitudes in subtle but found ways.

Why the deeply ingrained fear of rs? Man is not so far removed m his wilderness childhood as he y think. The horror associated th an attack by a wild beast releases ndamental fears that have been sub- ated for generations. Perhaps the nseless waste of lives in automobile cidents affects us less than one ath caused by a bear not only be- use the vaster numbers benumb us t also because the screams of crash tims cannot penetrate the civilized neer protecting us as incisively as primitive growling of wild beasts. perhaps the automobile is simply new for us to fear as intensely. ter all, we grew up as both predator d occasional prey of other wild animals and had a long time to learn to be afraid. We have lived with automobiles for but a historical second; the installation of intrinsic fear probably requires far more time.

Besides the statistical evidence in the bear's favor, defenders of the animal cite the scientific value of the creature. In natural areas, such as national parks, scientists can find relatively pristine ecosystems in which to study and learn. Diversity is the key to ecology, so the removal of any element would reduce the value of a system to science.

Other points made in favor of the grizzly are more abstract. As in arguing for the preservation of a fine painting or a musical composition, esthetic and spiritual values are invoked in defense of grizzly bears and their domain, the wilderness. The bear is formidable, exciting, and stimulating. Does not the human psyche need such varied nourishment for a healthy diet? While hiking in the grizzly's realm brings one in closer consciousness with these nebulous yet somehow vital intangibles, even the simple awareness that such wilderness continues to exist may be a mental tranquilizer for the frazzled city citizen. The world is not all concrete and steel and pollution; there is also the wilderness and the great bear.

Whatever methods scientists and park managers discover to make tourists safer in the national parks, there will still remain the problem of the grizzly with its aggressiveness and strength. But if we can yawn and accept the reports of tens of thousands of deaths from automobile accidents and mishaps in the home, can we not tolerate the exceedingly rare death due to a grizzly bear? The prospect of encountering a dangerous wild animal will always be unacceptable to some, but to others the image of a grizzly wandering over a high alpine meadow will remain a blessed indication of the diversity that remains for our senses and sensibilities. There will be more tragedies caused by grizzly bears, all of them regretful; but we cannot completely remove the risk without exterminating the great bear. That would be a far greater tragedy than the fate of Stoney Bear. ☐

Grizzlies cover large areas when foraging. Opportunistic feeders, two bears gorge themselves on roots in a thicket of young trees.

Stephen J. Krasemann; Peter Arnold Photo Archives

Celestial Events

by Thomas D. Nicholson

Sun and Moon The sun is in Leo from mid-August to mid-September, then in Virgo, well past the solstice, where its northerly position brings us the very long days and high diurnal arc of early summer. In this part of its apparent sidereal path, the sun moves rapidly toward, and eventually across, the equatorial plane. Days are still longer than nights, but are rapidly getting shorter. Nights catch up on September 26, when sunrise and sunset are exactly twelve hours apart.

The moon will be part of the evening sky till the end of August. Early in the month, therefore, we can expect to find a morning moon in the sky. In August, phases are last-quarter on the 6th, new on the 14th, first-quarter on the 21st, and full on the 28th; in September, last-quarter is on the 5th, new on the 13th, first-quarter on the 20th, and full on the 27th. Two eclipses result from the moon's motion during the period: a penumbral lunar eclipse visible in North America on September 27, and a solar eclipse on October 12—total in the Pacific Ocean, partial throughout most of North America.

Stars and Planets The show in the morning sky is a good one indeed. Very brilliant Venus is there and spectacular Jupiter, both becoming more prominent during the two months. In early August, they are relatively close, rising several hours before daylight dims them; Mars, although fainter, is prominent nearby, higher and to the right. During August and September, Venus moves well east (left) of Jupiter, but Mars moves closer, passes Jupiter, and then moves east (left) from it. Saturn, meantime, enters the morning sky in mid-August. By mid-September, Venus moves near and passes Saturn; a few days later, Venus passes the star Regulus in Leo, in both cases very close to the objects. From mid-September, for about ten days, you may expect to see Mercury, too, as a morning star, low in the east in the early twilight in one of its more favorable appearances as a morning star. At the end of September, Jupiter and Mars, both in Gemini, will be high in the south at dawn, while Venus and Saturn will be in Leo, lower in the southeast.

August 9–11: The waning crescent moon moves past Mars, Jupiter, and Venus, in that order. Look in the east before dawn.

August 10–14: Look for the Perseid meteors on any morning from 1:00 A.M. on. Best on the 12th, with up to 50 meteors per hour.

August 16: The moon occults (covers) Mercury about 6:00 P.M., EST.

September 4: Mars and Jupiter are in conjunction.

September 5: Mercury becomes a morning star.

September 7: The crescent moon is near Mars and Jupiter (the brighter) in the east this morning.

September 10–11: The moon is close to Venus and Saturn.

September 18: Venus shifts from right of Saturn.

September 19–24: Mercury is favorably placed for observing as a morning star, low in the east in the very early dawn.

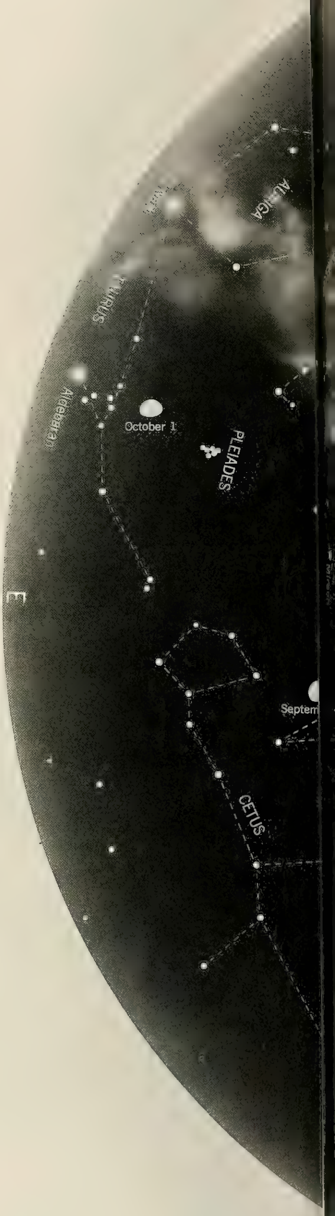
September 21: The star nearest Venus this morning is Regulus in Leo.

September 22: The sun arrives at the equinox at 10:30 P.M., EST. Summer ends and autumn begins in the Northern Hemisphere.

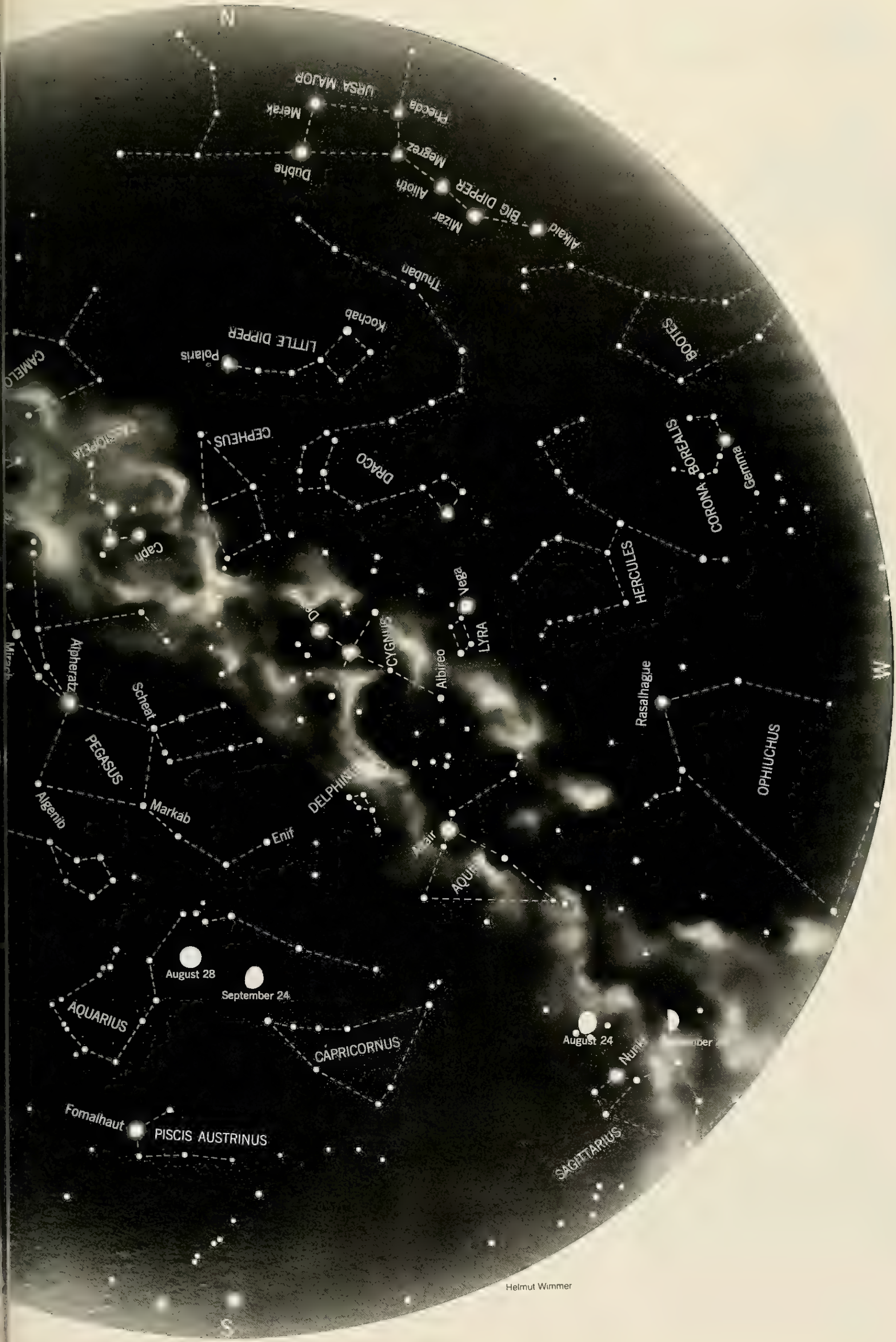
September 27: The full moon is the harvest moon.

October 4–5: In the morning sky, the moon is near Jupiter on the 4th, Mars on the 5th.

October 8–10: The moon again moves past Saturn and Venus.



★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 1:15 A.M. on August 1; 12:20 A.M. on August 15; 11:15 P.M. on September 1; 9:20 P.M. on September 15; 8:20 P.M. on September 30; and 7:20 P.M. on October 15; but it can also be used for an hour before and after those times.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Helmut Wimmer

by Bernard Nietschma

The Bambi Factor

Good and bad animals are made, not born

Knocking about in out-of-the-way places searching for information on animals and people produces enlightening perspectives on similar themes closer to home. During a recent trip around Australia, I tried to learn something about the roles animals play in different societies. Wherever I stopped, I asked about local wildlife: the native names of species, their habits and habitats, how and when they were hunted and used, and how they were portrayed in art and myth. One encounter in northwestern Arnhem Land, a cloistered corner of Australia's Northern Territory, gave me some perspectives on my own tribe.

A visit to an aboriginal village had led to a talk with some men about the area's wildlife. I went through my list of questions and the villagers graciously explained the different clan totems, and the various animal symbols and designs on bark paintings and other arts and crafts. They also told tribal stories involving animals and gave me the common names of local species. They were perceptive and helpful and a joy to talk with. When we finished the list, some of the elders began asking me similar, but culturally reversed, questions about my people. Fair enough. They had made every attempt to help me understand some of their way of life, why shouldn't I reciprocate and be an informant on my tribe?

I rummaged through the attic and basement of my memory, seeking favorite and most important American animal symbols, myths, and stories. I didn't find much: the bald eagle, a few James Thurber fables, and a lot on pets. The aborigines were satisfied, but I wasn't. Their questions stuck and nagged.

Later, the more I dredged up, the more I realized that much of our symbolic system is also heavily based on animals. Culturally blind, I was bumping into an imposing structure, and while I could make out some of the steps and doorways, I could not see the form until the roof fell in and I remembered the Walt Disney-Mother Goose Table of Animal Values. That memory jogger led me to comic books, cartoons, language, television, movies, and the cultural epaulets of identity found on T-shirts, Levi jackets, belt buckles, lapel buttons, automobile hoods and grilles, posters, trademarks, logos, and pennants. Animal symbols were everywhere. I had discovered a mother lode. Just as well I found it after my visit to Arnhem Land for if I had told then of the things that you're going to read, I might have been put on a wanted list as unnaturalist at large.

I once saw a bumper sticker in Los Angeles that read: "All the world is watching the United States, and all the United States is watching Walt Disney." Disney animals have had a major, governing influence on all of us. They are part of our cultural DNA, something that sociobiologists should look into. Someone in *Ti* magazine recently wrote about "D neyfication." What a word! Ev Abraham Lincoln, Fran Tarkentc Barbara Walters, Robert Redfor and General Motors haven't been " cated" yet, so you know Disney big stuff. The Disney crowd can ma or break an animal. Some Disney ai mal images approach symbolic cri cal mass.

John Livingston, in his imagin tive book *One Cosmic Instant,* poir out that right along with the multip cation table and the table of chemic elements, we have learned the Wa Disney-Mother Goose Table of Ar mal Values. Why is it, Livingst asks, that some animals are "good and others "bad?" Why are wolve coyotes, bears, vultures, weasel and snakes bad; while fawns, chi munks, rabbits, squirrels, ar beavers are good? This list can be e tended and appended to include an mal heroes and villains in com books, fairy tales, Saturday mornir television cartoons, and Sunday a ternoon nature programs.

Despite America's high per capi consumption of meat, the table of an mal values has it that meat eaters a the bad guys, and seed-grass-bar eaters are the good guys. You a what you eat, according to Adell Davis, which appears to apply, a well, to fictional animal characters.

Most of the animals in fable tales, films, and comic books are er gaged in make-believe events. Chi dren and consenting adults reall

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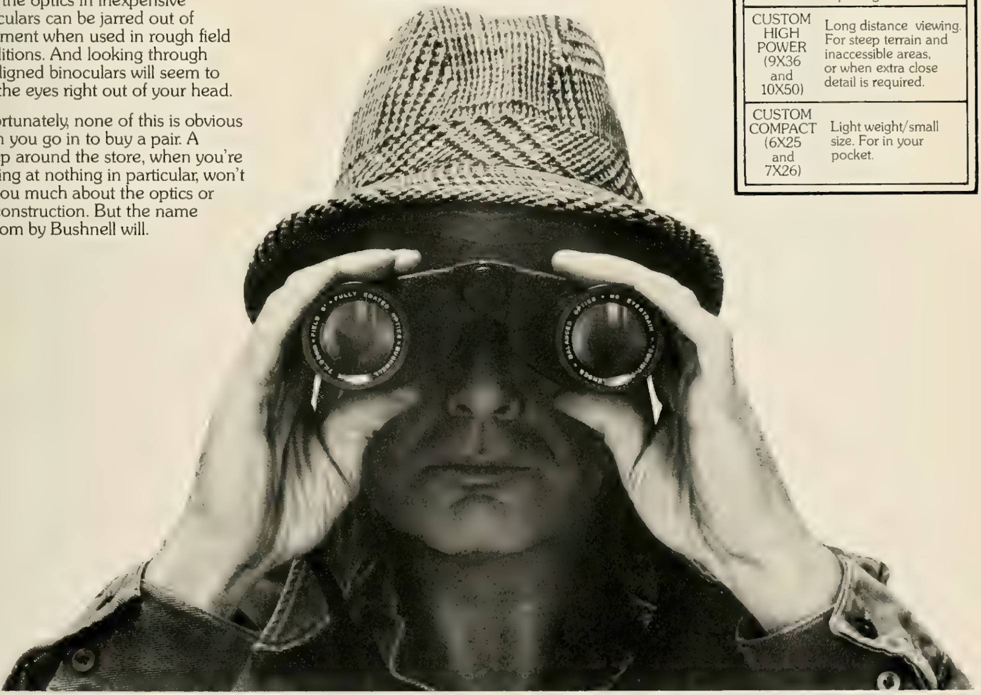

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don't buy that sort of skewed reality, right? (Make a list of animals and ask your children to choose the good and bad ones. You might want to use some less loaded words.) Make-believe animal scenarios are made believable through humanlike plots, social and interpersonal relationships, and dialogue, much of which carries moral and ethical values. However they are drawn, the animals' faces are simply shrunken human heads that show every grown-up wrinkle, frown, smile, and wart from our experiences, and which preview the adult world for children.

The table of animal values is really a table of human values. Nonhuman animals know nothing of nastiness, saintliness, greed, benevolence, cruelty, or cuteness. Livingston adds that we have failed to realize the utter indifference of nature to human values. But all must be seen in human terms and all must be possessed with human values.

A veritable zooful of animals roams our symbolic landscapes —exotic wild animals, domesticated farmyard creatures, pets. They are found in epithets, clichés, analogies, metaphors, and similes—and in barrooms and churches. If I were to call someone a "vulture," "maggot," "dog," "sheep," "pig," "toad," or "baboon," they would in all likelihood get mad. Yet if I said someone was a "lamb," "tiger," or "fox," they would take it as a compliment. Of the wide range of physical attributes and behavioral characteristics of animals, we have ignored most and substituted human characteristics to condense and heighten an image or to evoke a feeling.

Many of the images of animals in our language are the residue of cultural lint traps. Anything loose and unattached goes through the proverbial wash: some ideas and words are flushed; others stick to the conceptual screen. On first appearance, a new animal epigram may have the impact of a potent new symbol—"pig" of the 1960s or "turkey" of the 1970s. The more successful it is, the more readily it is assimilated into automatic responses and folk images.

Take "turkey." That single word can evoke fits of near hysteria among my son and his friends. The word is a regular on television and has even been programmed into one of the home video games: in the tick-tack-toe game, "You Lose Turkey" flashes on the screen, implying more than simply having lost the ga "Turkey" will probably die f overuse by the 1980s as "squir did after the 1950s. The next an is up for grabs. (We may move vegetables. My personal pick to c is "turnip.")

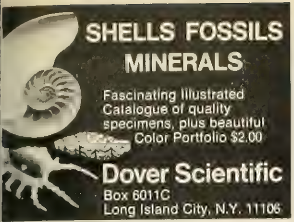
And then there is the use of word "as," commonly in a simile tween a human concept and a spe animal, such as "crazy as a loo "dumb as an ox," "stubborn mule," "slippery as an eel," "br as a lion," "big as a whale," an on, ad nauseam. Such similes co tute one of our national cultural tr

I tried to imagine the outcome being weaned and raised solely conventional folk animal wisd Bats, loons, and jays are crazy, owls are wise. Peacocks, butterfl and fawns are beautiful, whereas rillas, baboons, pigs, dogs, and to are ugly. Ostriches, sheep, and geons are stupid; apes have too m body covering, while jays have little. Crabs and hornets are alw mad or nasty; goats and mules stubborn; bears are rough and lan gentle; mice and clams are qu wolves, vultures, and hyenas are e and always up to no good; ants a shrimps are about the same size.

From this list of imaginary anir characteristics, one would have conclude that, with the exception bees, all insects and arthropods bad; anything found in fresh or s water is likely to be dangerous, o or very big; and reptiles and amphi ans are to be avoided. Birds are mixed bag, some of the small ones OK except for the crazies, but the b ones are either dumb or eat rott meat. Some of the mammals are cious and ugly, although a few can approached with caution.

As for pets, livestock, and farr yard animals, they may be our be friends, yet they are often our wo enemies in common speech. "Dog "bitch," "pig," "hog," "horse "parrot," "chicken," "goat "cow," "sheep," "canary," a "pigeon" are all derogatory. For the attention and money devoted pets, and all the dietary and econom importance of the domestic m nagerie, one might assume that th wouldn't be such verbal victims.

The animals in our language a perceptions have solid niches in o society. Animal symbols can be pov erful. They have to be chosen wi care. I mean, would you buy a car th was called a Whale, Toad, Moose,



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In discussing culture, anthropologist Marvin Harris wrote: "In a time when many are eager to experience altered states of consciousness, we tend to overlook the extent to which our ordinary state of mind is altered." Although animal symbols are important, they do not yet have the totemic social significance in our culture that they have for many other peoples in the world. Most of us do not form relationships and economic exchanges because of animal images or totems. But some people are so emotionally aligned with animals that this may change. I remember a woman who came up to me at a party and said "I'm into whales. How about you?" I call this the Jonah Factor. It may someday lead to the point where social and economic relationships are based on animals, depending on such things as what pet you own or which endangered species you are worried about.

Animals in homes, in zoos, and in the wild have become cultural artifacts. In this column ten years ago, Marston Bates wrote that "the forests that are gone and those that are left as parks or reserves, the animals that are protected and those that are persecuted—our whole ecosystem is shaped by the concepts of our culture. Our troubles stem from our conceptual environment. We made it. All we have to do is change it!"

Our illusions of imaginary animal traits may become so convincing, so persuasive, that they become reality, and we will see animals that really are too ugly, too stupid, too big, too crazy, too greedy, or too violent to care about any more. All the negative, demeaning symbols in our language should be rare or endangered, not the animals. Let the whales swim deep, the bats fly free, and the wolves roam without anything but our best hopes and strongest protection.

Bernard Nietschmann has completed his field work on dugongs in Australia and will be returning home sometime in August.

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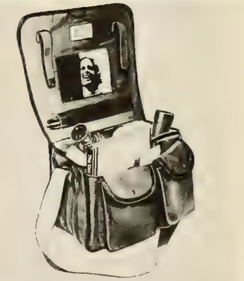

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by Stephen P. Ma

Rings Around Uranus

A major and unforeseen finding indicates that the seventh planet from the sun is encircled by five rings

In a prime example of serendipity, one of the principal astronomical discoveries of modern times was made last March by scientists who were not looking for what they found and were, in fact, using a research aircraft designed for an entirely different purpose. The discovery was that rings like those of Saturn also exist around the planet Uranus. The finding was so unexpected that both the airborne observers and at least one team viewing Uranus from the ground on the same night thought at first that their instruments were malfunctioning.

Decades of prior observation had seemingly established that Saturn was the only ringed planet. This conviction was such an accepted "fact" that when, in 1975, a Harvard University astrophysicist concluded that rings must have formed around Uranus early in the planet's history, he felt compelled to add a tentative explanation for a process that presumably had later destroyed them. However, the recent discovery sho that Uranus has at least five rings one more than Saturn. They are mu narrower than those of Saturn a therefore reflect far less light from sun. In addition, Uranus is fartl from the sun than Saturn and is a farther from the earth. These facto make the newly discovered rin more difficult to see than Saturn's a help explain why they weren't fou earlier.

The events leading up to the d covery of the rings of Uranus beg in 1973, when an astronomer at H Majesty's Nautical Almanac Offic a unit of the Royal Greenwich Obse vatory in England, predicted that t distant planet would occult, that i briefly block the light from a fai orange star in the constellation Lib on March 10, 1977. The astronome Gordon E. Taylor, pointed out in t *Journal of the British Astronomic Association* that "no useful observ tions of such an event have ever bee made and adequate preparation is e sential in order to obtain the max mum amount of information. . . ."

An occultation is the passage of t moon, a planet, or the satellite of planet in front of another celestial o

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12: 34 56

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AUGUST 15th FRIDAY

8: 15 FR

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ject, such as a star or another pl
or satellite.

The importance of the occulta
of a star by Uranus, as perceive
1973, was the opportunity the e
would offer to time the rate at wl
the star fades out as it passes bel
the planet's thick, cloudy atn
phere. Such information would al
planetary scientists to detern
various properties of the Uranus
mosphere, such as the average we
of the constituent gas molecules
the possible presence of high-altit
cloud layers. Timing the star's dis
pearance and reemergence wo
also provide a more precise measu
ment of the planet's diameter and p
haps even of its shape. Calculati
show that the rotation of Ura
should cause it to bulge at the eq
tor, so that its equatorial diameter
ceeds the one measured from pole
pole. Jupiter has a large "equato
bulge" of this type. While the eq
torial bulge of Jupiter is a confirn
phenomenon that has been accurat
measured, the corresponding obs
vations of Uranus were in cons
erable disagreement in 1973. Rec
nizing the importance of resolvi
this discrepancy, a group of Urar
experts that met in September 19
at Moffett Field, California, adop
a resolution directing "the attenti
of observers and funding agencie
to the 1977 Uranus occultation.

One planetary physicist, James
Elliot of Cornell University, arrang
to observe the Uranus occultati
from NASA's Kuiper Airborne C
servatory, a C-141 jet transp
equipped with a 36-inch telesco
and normally used to observe infrar
light that is absorbed in the eartl
atmosphere. During the March obs
vations, the aircraft cruised at an al
tude of 41,000 feet, above 75 perce
of the atmosphere. Elliot's measur
ments were made in red light, whi
is readily observable by instrumer
on the ground, but the need for t
aircraft in this case arose from the c
cumstances of the occultation: t
best region for viewing it was at se
not on the land. Also, a high-altitu
observing facility was desired
eliminate the risk that cloudy weath
might prevent viewing.

A few weeks before the occultatic
was to occur, it was found that tl
occultation track, that is, the zone c
the earth's surface from which tl
event would be visible, had been i
accurately predicted. New phot
graphs made by two Lowell Observ

y astronomers with a 61-inch tele-
ope in Flagstaff, Arizona, showed
t the star to be occulted was actu-
y slightly north of its previously
ed position. It was also found that
nor corrections were necessary in
computed path of Uranus through
sky. As a result, the predicted oc-
tation track shifted to the south.
r two teams of Arizona astron-
iers stationed at the Perth Observa-
y in Australia this meant that their
truments were now located near
l perhaps outside the northern limit
the occultation track. Elliot how-
er, only had to shift the flight path
the airborne observatory.

On March 10, shortly after 20
urs, Greenwich Mean Time, the
borne observatory began tracking
faint orange star SAO 158687.
cused by the 36-inch telescope, the
ht of three colors in the red region
the spectrum was isolated by filters
l beamed to sensitive photoelectric
uipment. There, weak electrical
nals were generated in the same
y that daylight striking a photog-
her's light meter produces an elec-
current that deflects the meter
edle. The signals from the photo-
ctric equipment were amplified
d routed to recording devices, in-
ding a "strip chart recorder." The
ter device, which was closely
tched by Elliot and his associates
the flight proceeded, has moving
ns that record the intensity of the
nals on a continuous roll of graph
per. A television monitor also dis-
yed a picture taken through the
escope, thereby providing a visual
eck on the accuracy with which the
r was tracked as the plane flew over
Indian Ocean.

At 20 hours, 11 minutes, 43 sec-
ds, Elliot and two aides from Cor-
ll had their first intimation that
mething unexpected was in the
rks. Although the star was not yet
e to be occulted by Uranus, the
ns on the chart recorder suddenly
pped, indicating a brief diminution
the measured light. At first, a prob-
n with the tracking system was sus-
cted: perhaps the telescope had
inted away from the star. How-
er, the television monitor showed
teady image of Uranus, indicating
at the telescope was under control.
actuality, the outermost ring of
anus (since dubbed the "epsilon"
g) had just passed in front of the
r. The unexpected event had been
tected 74 seconds earlier, farther
ck on the occultation track at Perth,

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by a surprised Lowell Observa astronomer, Robert L. Millis, two associates.

Millis, whose team thus gets credit for the first reported obse tion of a Uranian ring, later indic to a reporter for the Flagstaff *Sun* instrumental failure had been mentarily suspected when S 158687 first seemed to fade at Pe Nevertheless, the observations wi 24-inch telescope were continued additional occultations were corded. Two rings ("delta" "alpha") were missed when Lowell astronomers halted their servations at two different mome to recenter the telescope pointi Further, a few less certain occu tions were observed, perhaps indic ing that more than the five definit established rings exist.

It later turned out that the predic occultation, that is the occulting the star's light by Uranus itself, not visible from Perth, but Milli persistence was rewarded by the servation of the ring occultatio The Perth observations were term ated by the interfering glare from rising sun; thus the Lowell astr omers did not record the five defir occultations that occurred as the posite side of the ring system pass in front of the star.

Aboard the aircraft, however, liot was able to record both the f "inbound" occultations and the f "outbound" ones. (The occultatic were not sighted visually nor w they photographed. They were ferred from dips indicated on strip chart recorder.) From the measurements, Elliot could pro beyond a reasonable doubt that events were caused by a circular ri system and not, say, by five pr viously unseen moons. It appears th the outermost ring, epsilon, might d viate slightly from a true circle or m be slightly tilted with respect to t other rings.

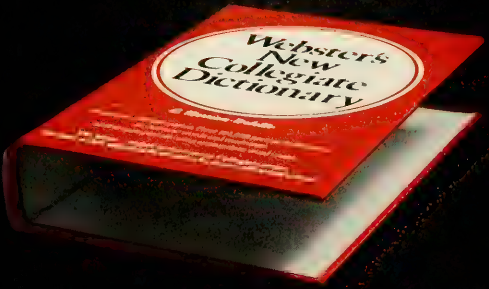
Other observations of the ring c cultations were made with a 102-ce timeter telescope of the Indian Ins tute of Astrophysics at Kavalu where two astronomers at first su pected that they had discovered a ne moon of Uranus, and at Naini Ta India, where astronomers from th Uttar Pradesh State Observatory, e pecting only the occultation of th star by the planet, began viewing to late to record the first inbound eps lon-ring occultation, but did dete the four other inbound occultation to the west, the five outbound ring ultations were observed by an asnomer at Cape Town, South ica. Only the airborne astroners, however, recorded all the inind and the outbound events.

What is the significance of the gs? In 1975, an expert on planetary llites at the University of Arizona ote in *Icarus*, the leading profesnal journal of solar system rerch, that "Uranus' satellite system he least studied and the least unstood of the major satellite sysns. . . ." He referred to Uranus's known moons, which revolve und the planet in the same direcn and in a common plane, tilted ost at right angles to the planet's it around the sun. In the very same ie of the journal, A. G. W. Camn of Harvard University, a leading hority on the origin of the sun and nets, proposed that rings might e have formed around Uranus as ogical consequence of the same cess that formed the five moons. cording to his theory, the moons med from a rotating disk of matter t circled Uranus early in its hisy, and the rings represent remnant ticles from this disk. Like the rings Saturn, the rings of Uranus are not id objects but must be composed an enormous number of small ins of ice and stone. Recent obserions suggest that the rings of San are made predominantly of ice, roposition that helps explain why rings have been found around iter and the other planets that are ser to the sun. Their ice particles uld have evaporated.

At one time, the status of Saturn as *only* ringed planet was taken for nted. The discovery of rings und Uranus suggests, however, t ring formation may be a basic cess in planetary evolution. If so, ptune, the next planet beyond anus, may also have as-yet-undeted rings. When I visited the Kitt ak National Observatory headarters at Tucson in early April, y a few weeks after the Uranus gs discovery, it was therefore not surprising to find an expert planey observer busily poring over oks and formulas, beginning the rk of searching for stars that might neday be occulted by the still-hyhetical rings of Neptune.

phen P. Maran is an astronomer NASA's Goddard Space Flight nter in Greenbelt, Maryland.

rip-off



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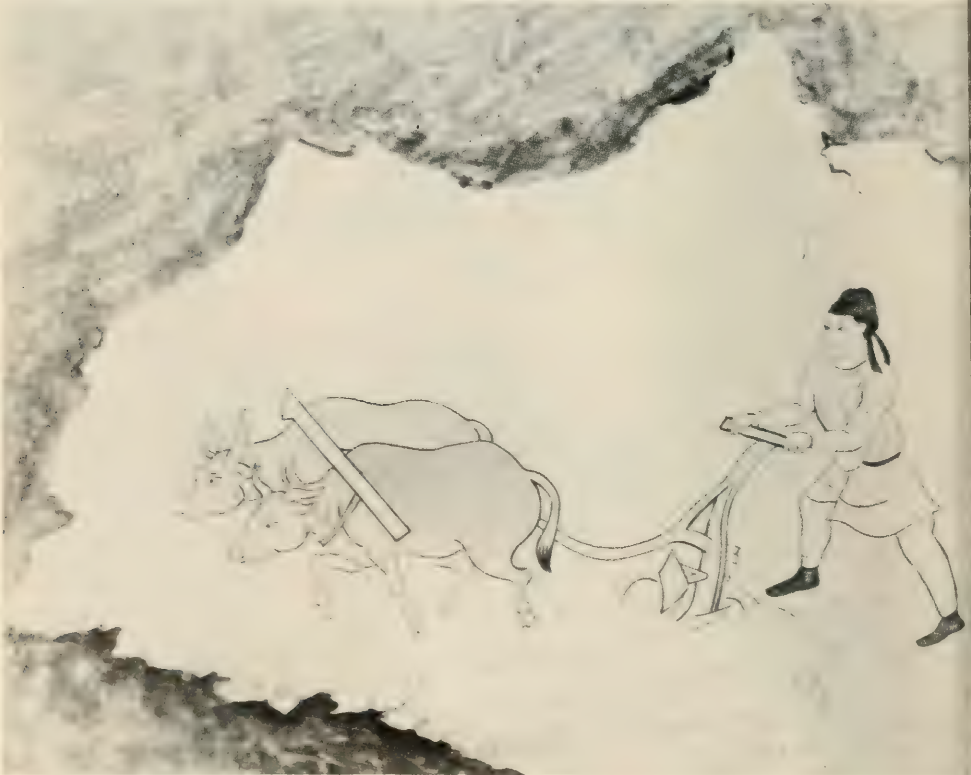
The Chinese Way of Eating

FOOD IN CHINESE CULTURE, edited by K. C. Chang. *Yale University Press, $20.00; 429 pp., illus.*

"Appetite for food and sex is nature," said Kao Tzu, a Chinese philosopher during the Warring States period. Indeed, food and sex would seem to be the two most basic human activities: the former is necessary to the individual's survival; the latter is necessary to the species' survival. Yet students of the human scene, social scientists, have neglected the study of these activities possibly because they are considered too earthy or too gross. It is therefore of some interest that several recently published works have attempted an anthropological view of food. One of the most successful is *Food in Chinese Culture.*

Food and sex are often associated. In our own culture, one need only think of the English vocabulary used to talk about sex, with its emphasis on metaphors having to do with eating or with specific foods. Or the scene in *Tom Jones,* where a rep of suggestive foods, including o ters and hunks of meat, serves as occasion for sexual seduction. Chinese language also makes use gastronomic images in sexual scriptions; so, a sixteen-year-old v gin may be described as being "sw and ripe as a melon ready for c ting." Food and sex are intertwi in the first great realistic Chin novel, *Chin-p'ing-mei* ("Golden I tus") written in the sixteenth centu in which simultaneous ingesti



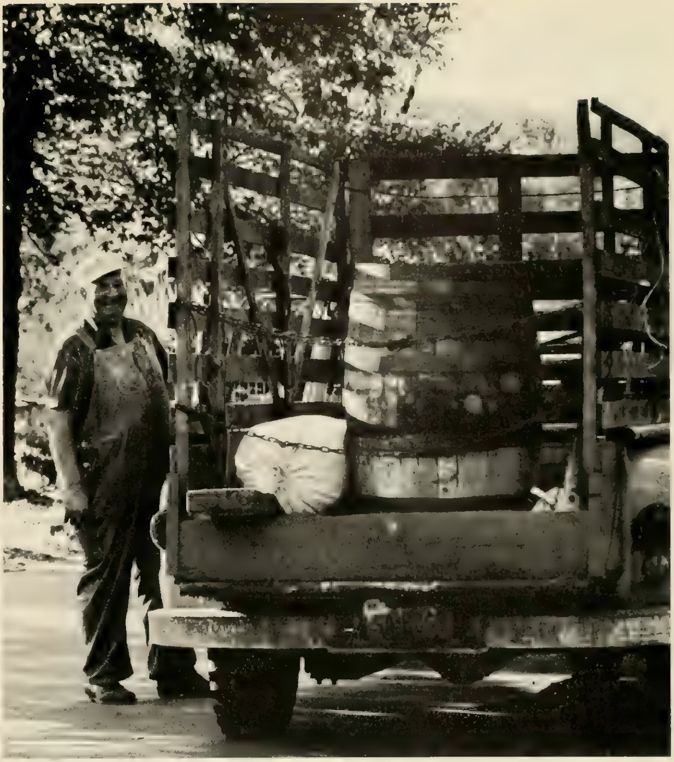
Courtesy Yale University Pr

T'ang mural of cattle plowing field

d copulation occur once or twice. All societies must limit the natural petites associated with food and ‹, but the range of variation in cus- ns pertaining to food is infinitely ;ater than in those involving sex. l men must eat, but the foods they :, the ways in which these are pre- 'ved, prepared and cooked, the iounts, variety and times of eating, : tastes that are liked and disliked, : utensils and etiquette of serving od, and the beliefs about the ›perties of particular foods all vary seemingly infinite ways. Even thin a culture, there are variations sed on class, region, religion, so- ıl occasion, sex, and age, and there : variations over time.

Most people would probably agree ıt, along with the French, the Chi- se place a greater value on food and stronomic delights than most cul- 'es. Even Maoism could not regi- ›nt Chinese eating habits: commu- l mess halls were one of the first ıovations of the Great Leap For- ırd that had to be abandoned. It is :eresting to note that in spite of the nilarity between French and Chi- se cultures in the high value that th place on food, they differ radi- lly in the role they assign to sex.

If food is an important part of cul- 'e, it is also a reflection of deeper lues. Since at least the Chou dy- sty (c. 1100–256 B.C.), the Chinese ve recognized a division of food :o *fan* (grains such as rice, the cul- 'al superfood) and *ts'ai* (mixed veg- ıbles and meats). The former are rved in individual bowls (the proper quette is to bring the bowl to the ›s and shovel the rice in with chop- cks), while the latter are served in 'ge bowls placed in the center of the ›le, from which everyone helps mself. *Fan* serves as a bland filler absorb the rich variety of smells, vors, colors, and textures possible *ts'ai*. Unlike the typical American ·al of steak, potatoes, vegetables,



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AMPHIBIANS AND REPTILES—*8 Mondays starting October 17, 7:00-8:30 p.m. Fee: $30.*
Limited Enrollment.

Using color slides and materials from the Museum's collections, Dr. Charles J. Cole, Associate Curator in the Museum's Department of Herpetology, discusses classification, evolution, adaptations to various modes of life, uses, and how scientists investigate the biology of amphibians and reptiles. Includes a "behind-the-scenes" tour of the Department of Reptiles and Amphibians and a preview of the new Hall of Reptiles and Amphibians which opens to the public later this Fall.

SOCIAL BEHAVIOR OF ANIMALS—*7 Mondays starting October 17, 7:00-8:30 p.m. Fee: $35.*

Dr. Ethel Tobach, Curator at the Museum and Adjunct Professor in Biology and Psychology at the City University of New York, discusses the evolution and development of social behavior as an important factor in ecological adaptation of representative species. Experimental studies with live animals will be demonstrated.

THE WORLD OF BIRDS—*6 Tuesdays starting October 11, 7:00-8:30 p.m. Fee: $25.*

Using color slides and study skins from the Museum collections, Kenneth A. Chambers, Lecturer in Zoology at the Museum, introduces the history of birds, their classification, structure and other interesting aspects such as reproduction, display and migration.

WILD FLOWERS OF THE NORTH—*5 Thursdays starting October 13, 7:00-8:30 p.m. Fee: $20.*

In this slide-illustrated series, Helmut W. Schiller, Lecturer in Botany at the Museum, explores the world of wild flowers of northern mountains, coniferous forests, and wetlands, from Alaska and the Pacific Northwest across to the New England States.

INSECTS: EARTH'S MOST SUCCESSFUL ANIMALS *—6 Thursdays starting October 13, 7:00-8:30 p.m. Fee: $25.*

Alice Gray of the Museum's Entomology Department gives an informal series of slide-illustrated talks on some of the fascinating aspects of the world of insects, including structure, life-histories, environmental relationships, and the significance of insects to man.

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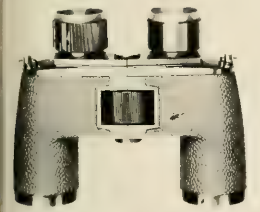

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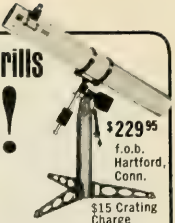
and salad all standing in isolation, as if under analysis, the *ts'ai* must be a harmonious blend of bite-sized pieces of a variety of meats and vegetables—reflective of the harmony so important in the Chinese social order between Man and Nature, Man and Man, Ruler and Subject.

China offers an immense regional and temporal diversity of gastronomic arts. Chang's book emphasizes the latter, taking us to myriad feasts (and famines), from the time of Peking man (described by Chang) to that of Communist man (by Vera and Francis Hsu, Eugene and Marja Anderson), by way of the dynasties of Han (by Ying-shih Yü), T'ang (Edward H. Schafer), Sung (Michael Freeman), Yüan and Ming (Frederick W. Mote) and Ch'ing (Jonathan Spence). Along the way, we are tempted by pages and pages of fascinating culinary delights, not the least of which was the custom, during the T'ang dynasty, of stuffing newborn rats with honey and allowing them to crawl about the dinner table to be delicately picked up with chopsticks and popped in the mouth alive. Or steamed dumplings filled with minced humans, mentioned in *The Water Margin* as a specialty of "black deed inns" where evil persons plotted crimes. (Indeed, cannibalism is quite ancient in China; some archeologists believe Peking man was a cannibal because of the many broken skullcaps in his caves.)

In addition, each region, even each locality, has a traditional cuisine: the dishes of Szechwan are hot and spicy; sweet and sour dishes are characteristic of Canton; Fukien is famous for its soups; Shantung cooks are heavy on garlic and seafoods; Honan is the home of sweet-and-sour freshwater fish, and so on.

Behind this regional and temporal diversity, however, one can discern elements of unity. As Eugene and Marja Anderson argue so cogently in their excellent contribution to this volume, Chinese cuisine makes use of a basic repertoire of ingredients and technology, of methods of combination and preparation. The basic ingredients are rice, fish, pork, and vegetables (to which north China adds wheat, soybeans, and mutton). The technology includes a stove, the wok, capable of high heat, the cleaver used for dicing foods, and eating utensils, such as porcelain bowls, spoons, tiny teacups, and chopsticks. In the south, methods of



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combination emphasize tastes tha
piquant and pungent, with ferme
soybean products often comb
with vinegar, chili, or sugar. In n
China, less vinegar, sugar, and v
tables are used in favor of more
ame oil, star anise, garlic, onion,
soybean jams. In the south, foo
cooked quickly with peanut or
oil—a speediness that reaches its
gee in the lightninglike stir-fr
and quick boiling of the Canton
In the north, slower preparatio
used for pot dishes, red-coo
dishes, and simmered dishes.

The foundation of this unity beh
Chinese cuisine is a minimax st
egy: minimal input for maximal
put in growing food and in cooki
The Chinese have been remarka
free in accepting foods from ot
cultures and remarkably innovativ
making much of the most comm
ingredients. Past famines have alm
completely eliminated food taboo

But, of course, food is more t
a means of appeasing hunger; it a
serves important personal, soc
and religious functions. Diet is p
of medical prevention and treatme
The Chinese, as do many peopl
categorize foods as hot (*jê*) or c
(*liang*); for example, spicy fat p
is hot, watercress is cold, rice is b
anced. The sick may be treated
feeding them hot foods for disea
believed to be cooling and vice ver
The healthy maintain a balance
tween hot and cold foods, as well
between dry (*kan*) and wet (*sh*
foods, and take strengthening fo
(*ch'i*), such as ginger and ginseng,
good measure (much as America
take chicken soup).

Virtually every eating transacti
in China is social; one seldom eats
isolation. Major events, such as we
dings, require major feasts. Leade
both informal and official, must ma
regular appearances in tea shops a
restaurants and sponsor feasts—t
more official and important the p
son, the more frequent and splend
the feasts must be. Certain foods a
markers of prestigious occasion
Sharks' fins and bird's nest soup a
used not so much for their taste b
as a means of underlining the imp
tance of an occasion. Because th
are rare, expensive, and conspicuou
these foods carry the message that t
feast is extraordinary. "In short, fo
is communication. No conclusive
important business can be transacte
no firm contacts made, no importan

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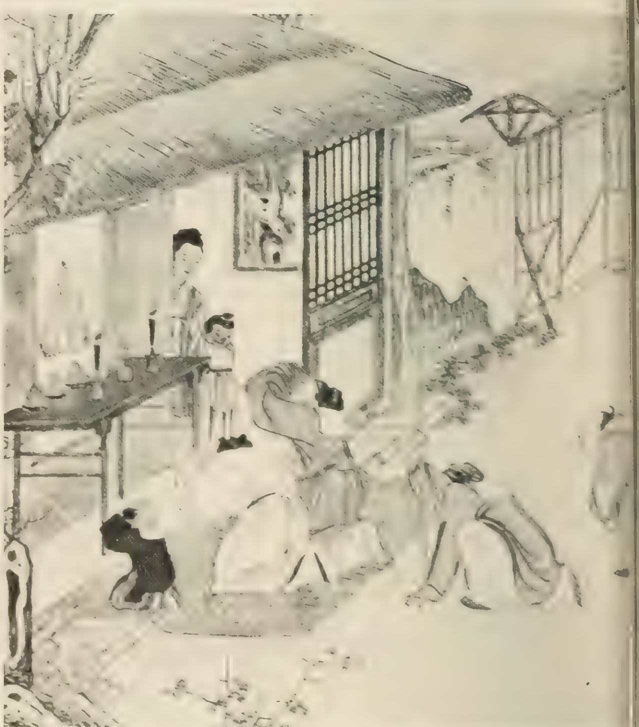
marked or asserted, without the sharing of food. The expense, status value, quality, and setting of the food communicated more about the critical social dynamics of the situation than language can; much that is hard to verbalize, and more that would be impolite to verbalize, is communicated by this channel. Such use of food is worldwide, as every anthropologist knows; but no culture has developed it more than the Chinese."

The Chinese even make use of food to communicate with the supernatural. The most direct contact that each family has with the celestial bureaucracy is through the Stove God, who once each year ascends to the spirit world to make his report on the family's conduct and activities over the past year. Of course, shortly before he is scheduled to make this report, the family plies him with tasty, glutinous rice cakes. Food offerings used to be buried with the dead (one source of our knowledge about past gastronomic customs), but now the spiritual essence of the food satisfies the supernatural. Although some spirits have favorite foods and every festal occasion has its traditi
dishes, there is a hierarchical ran
food offerings, from lowest to h
est: (1) tea and fruit, (2) bowl
noodles and wine, (3) duck, chic
and pork dishes, and (4) a pig, e
cially a "golden pig" (roasted w
with a sugar glaze that gives it a s
let gold color). Although Wester
often interpret these festival meal
unnecessarily lavish extravaga
that add to the burden of daily
gality, it must be remembered
pigs and chickens are very effic
converters of wastes into high-qua
protein: protein, moreover, wl
people might otherwise feel unabl
afford, and the lack of which wo
in the long run have detrimental
fects upon their health.

Food in Chinese Culture offers
reader no recipes, but its scope
perspective offer new ways of un
standing food as part of culture.

Alain Y. Dessaint is assistant p
fessor of anthropology at the U
versity of Maryland. His book M
norities of Southwest China *will*
published later this year.



Courtesy Yale University P

Offerings being made to the god of agriculture (from a 17th-century woodcut)

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A Conjugation of Snails

photographs by Hans Pfletschinger

The edible ground snail, *Helix pomatia,* is an animal with an appropriate common name. A terrestrial species found throughout central and southeastern Europe, it is viewed as a culinary delight by a variety of cultures. The French in particular have developed a number of *escargot* dishes featuring this species.

Land snails are more specialized and recently developed than their marine relatives. Breathing through a kind of lung, rather than the gills used by marine species, land snails have had to evolve adaptations to meet the dangers of desiccation and cold. Edible ground snails, for example, hibernate during the cold European winter months. They do this by burrowing among roots and leaf mold to a depth of up to thirty centimeters (about twelve inches), then roofing the excavation with a mixture of leaves, soil, and mucus. Once in its burrow, an edible land snail also forms an epiphragm, or lid, over its shell aperture as further protection against cold. The epiphragm is sufficiently porous to allow humid air to pass through.

Spring sun elevates the temperature in the burrow, and when sufficiently warmed, the edible ground snail breaks through its epiphragm and digs its way to the surface. Most active during periods of high humidity, the snail forages primarily at night. Equipped with thousands of minute teeth on a chitinous, bandlike radula, the snail rasps off bits of vegetation. Their preference for broad-leaved plants has led snails to be common inhabitants of gardens and vineyards.

May and June are the main mating months for this hermaphroditic species, although mating may continue into summer. Cross-copulation (photograph 1) takes place when two partners erect the anterior parts of their bodies and press firmly together. The mating couple rock back and forth and shoot calcareous darts, up to twenty millimeters long, into each other. These darts, formed in a genital gland, probably serve as a stimulus to mating. Shortly after the darts are exchanged, sperm transfer begins. Sperm is stored in a receptacle within the snail's body. Four to six weeks after mating, the fertilized eggs in each snail have matured enough for deposition to take place. The snail seeks a shady, humid, semibarren spot where the earth is not too hard. With its foot, the animal digs a shaft about the width of a finger. The excavated earth is arranged around the lip of the shaft, forming a small mound. At a depth of five to six centimeters, the lower part of the shaft is widened to form a chamber. The digging process takes an entire day.

After a rest period of several hours, egg laying begins (photograph 2). The genital opening is located between the mouth and eye tentacle on the right side of the head. The pea-sized eggs (photograph 3), are rich in yolk and covered with a mucous coat that lubricates their passage through the genital opening. A substance in the mucus, possibly an enzyme, prevents the eggs from rotting or being attacked by fungi while they maturate in the egg chamber.

There is a long interval between the laying of each egg, more than thirty minutes in some instances. The number of eggs in a clutch can vary from a low of thirty to seventy or more. In the clutch pictured, sixty-nine eggs were laid, the first at 7:30 A.M. and the last on the evening of the following day—a period of thirty-six hours.

The eggs are covered by a soft, white, calcareous shell that allows humid air to pass through. Desiccation is a threat, so the adult plugs the shaft leading to the egg chamber, using soil from the shaft excavation mound as building material. As the parent snail crawls over the mound, earth particles stick to its slimy f
The snail then crawls in tight cir
around the shaft and scrapes the
ticles off, repeating the process
the shaft is completely plugged.

About two weeks after deposi
(under controlled conditions), ha
ing of the young snails is indicate
small droplets of water on the e
During the next two days the e
change color, and begin to disi
grate (photograph 4). Disintegra
is due to the young snails inside
sorbing calcium carbonate from
egg covering to form their own she
Twenty-four hours later, the en
egg covering has disappeared and
young have hatched.

After hatching, the young att
themselves to the walls of the
chamber (photograph 5). They be
their first active feeding by eat
away at the surrounding soil.
trients, in the form of organic s
stances in the soil, pass through
hatchlings. Calcium carbonate is a
absorbed, and the bodies and sh
of the young grow larger a
stronger.

As they eat away at their
chamber, the young snails enlarge
cavity sideways and upward. O
the next three to four weeks,
hatchlings nibble the soil, continua
enlarging the chamber and near
the surface. When they are wit
five millimeters of the ground s
face, the snails begin to break throu
(photograph 6).

Once above ground, (photogra
7), the hatchlings disperse tow
nearby vegetation to begin the h
bivorous diet they will maintain
adults. Their numbers are reduc
sharply by predators such as beetl
ants, and toads, and by farmers a
gardeners seeking to eradicate th
from their plots. Of those that s
vive, many succumb to still anoth
type of predation: humans on t
prowl for another meal of *escarg*

Frederick Hartma

All photographs through Peter Arnold Photo Archives

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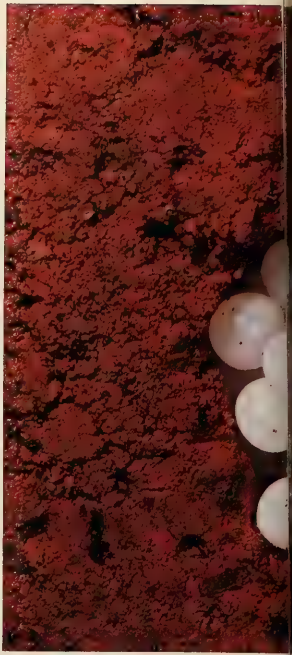

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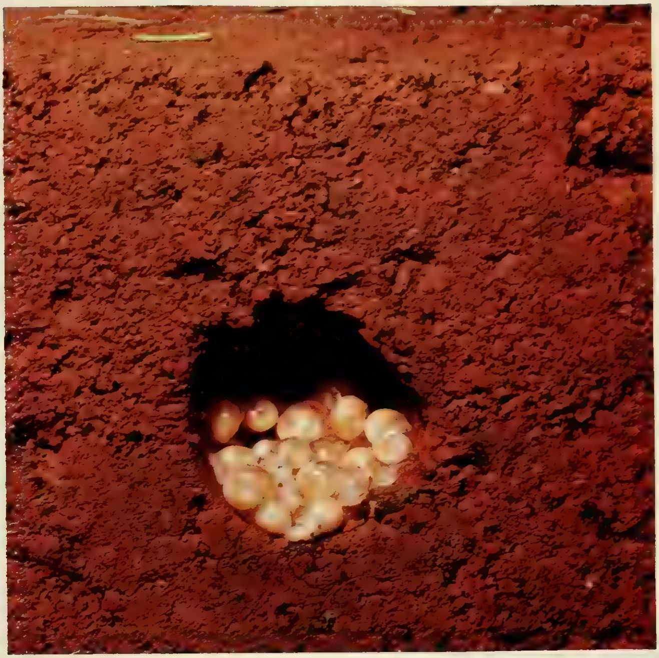

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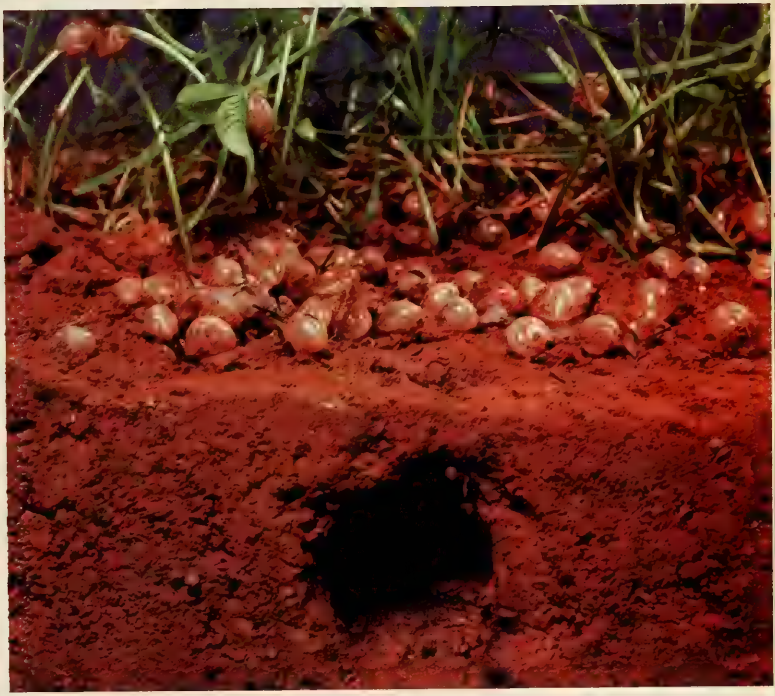

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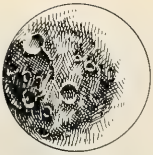

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A Matter of Taste **by Raymond Sok**

Up from Catsup

The tasty, old-fashioned tomato is the victim of its own success

The tomato, as everyone knows, is an endangered species. The spheroid, commonly red and tangy fruit has not, of course, been pursued to the point of extinction, like that other prized native of Peru, the vicuña. Indeed, from its first encounter with the conquistadors (tomato derives from the Nahuatl *tomatl*), *Lycopersicon esculentum* went on to conquer the world in *salade de tomate, salsa di pomodoro,* and in that most reliable lunch-counter sandwich, the BLT. So popular is this once-maligned cousin of the deadly nightshade (and other Solanaceae family members, such as the potato and the eggplant) that, year-round, no supermarket can afford to be without it. And that is the trouble.

But you know that already. You have heard that mass-produced, artificially ripened, mechanically picked, long-hauled tomatoes aren't worth the vines they were forced to grow on, in Florida or other agronomically "advanced" centers of tomaticulture. Even without the barrage of antitomato propaganda emanating from James Beard and other epicures, who have lately been resorting to canned Italian tomatoes, you would have known by the evidenc mouth, tongue, and teeth that modern American tomato is a con sham. It has no taste and it won' splat.

Horticulturists, who should be loried as traitors to the proper sta ards and practices of their trade, h sold themselves to agribusinessr and have fabricated sturdy-walled matoes that can survive the truck cross-country without bruising squashing.

Fortunately, for a few weeks of year, local growers in all parts of country sell their own, antique-sty squishable, blotchy, tart, and sor times green-dappled tomatoes country stands. These tomatoes ar test of a good knife. And they put industrial tomato in the shade.

You too can grow them. And y should reserve the sunniest corner your garden or your fire escape fo few plants. (It isn't worth the ti and trouble, for most people, bother with seeds.) In temper zones, tomatoes, which are natura perennial, are grown as annuals a develop into spreading vines or ser erect plants. Among their other m apparent virtues, tomato plants of a convenient home laboratory for t study of the arrangement and gene geometry of a common type of lea

Tomato leaves usually grow in alternate (one leaf per node) arr

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along the leafstalk, or petiole. They also emerge, alternately, to one side—and then the other—of a central axis, just as feathers grow on two sides of a central quill. This configuration is, hence, known as pinnate (*pinna* is "feather" in Latin). And since a single leaf grows at the apex of the "quill," the tomato leaves are said to be odd-pinnate because of this unpaired, extra leaf at the end of the petiole.

Furthermore, as with leaf arrays in other plants, if you draw a line along the stem that connected the bases of successive leaves, you might, if you measure the segments cut off by the leaf bases on the resulting spiral and cogitate cleverly, rediscover the phenomenon known as phyllotaxy.

Before you reach for your dividers and your ruler, you should know that the neat ratios found in botany textbooks for phyllotaxy (from the Greek words for "leaf" and "arrangement") do not work out perfectly but only approximate whole-number perfection. Still, phyllotaxy does basically work out to be a complex mathematical regularity in the placement of leaves along a stem. To return to our example then, not only do tomato leaves have a visual, featherlike pattern but they also emerge along a spiral track that twists around the basically cylindrical surface of the stem. Furthermore, this array is mathematically specific; the same, for all tomatoes. The spiral line connecting tomato leaf bases must twist around the stem two times and run through five leaf bases before it reaches a (sixth) leaf that will grow directly above the leaf you started with. In other words, there is a recurring pattern in the arrangement of leaves around the stem. Every sixth leaf starts the twisting series anew.

The recurring pattern, in tomatoes, boils down to a ratio of 2:5—two full twists around the stem and five leaf bases. It is also the case that the angle of the arc of the spiral between two leaf bases is 144 degrees, which is two-fifths of 360 degrees. Or, if you looked straight down the stem, so that the vertical distance between leaf bases played no part in what you saw, the length of the arc between successive leaf bases would be two-fifths the circumference of the stem.

Botanists say, then, that tomatoes have a phyllotaxy of 2:5. Ditto for tobacco plants. But several other phyllotactic ratios have been observed in nature: 1:2, 1:3, 2:5, 3:8,

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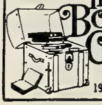

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8:21, and so on. In every case,
numerator is the number of cir-
around the stem and the denomi-
is the number of leaf bases in
attern or series. These observa-
also apply to arrangements of
s on pine cones, to the curving
of florets in sunflower disks and
ordering of cauliflower florets.
far as I know, no one has satis-
rily explained the genesis of
ratios. The so-called genetic
l, along which the pertinent, re-
ng segments have been marked
nay result from the geometry of
cells and the way they are
ed together. And it is also true
he "spiral" itself is really a kind
lix since it is a regular curve de-
ed on a stem that may, for most
length, be closer to a cylinder
it is to a cone. Helices invite
diose comparisons to the micro-
ic model propounded by Crick
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lls, DNA.
ithout drawing such high-flown
ections, we can still be properly
ished by an undoubted property
set of phyllotactic ratios. Look-
t them in the descending order
agnitude in which they are listed
above, we can see that, as the series progresses, the numerator of each fraction is the sum of the preceding two numerators; the denominators are, each, sums of the preceding two denominators.

This kind of series, in which each term is the sum of the two before, is known as a Fibonacci series, after its discoverer Leonardo Fibonacci, (Leonardo da Pisa), a twelfth-century mathematician. Fibonacci also introduced Arabic numerals to Europe, but his series brought him eventual personal celebrity, partly because it converges mathematically to 1.618, the Golden Section.

All this has undoubtedly led someone to see the hand of God at work in the humblest tomato patch. But it was demonstrated as far back as 1872 that there was nothing mysterious at all about the numerology of phyllotaxy. Fibonacci ratios are merely a mathematical description of the most efficient method for arranging leaves so that they do not keep sun off each other. Different-sized leaves produce different ratios. This is not only common sense, but a confirmation of the working of the fine hand of natural selection. Leaves that shade each other will shrivel, kill the plant, and consign its genes to oblivion.

Fortunately for tomato-lovers, their favorite plant exploits its 2:5 ratio to produce yellow flowers containing five stamens around a pistil with two (or more) carpels, which give way, after a 120-day growing season, to the fruit we crave.

The trouble with this happy result is that it works too well. Too many tomatoes at one time is a feast; it is also a glut. The agribusinessman's solution was to move to Florida and minimize the importance of seasons. You and I can either give away our excess or we can preserve it.

Thousands of Americans have recently rediscovered home canning. There was even a national shortage of Mason and Bell jars not long ago. (These are the tight-sealing glass containers most home canners prefer over metal containers.) This revival raises all sorts of complicated technical questions, and many books have been published that speak to the need of reeducating Americans to the special sanitary and mechanical requirements of canning.

These "technicalities" are no joke. Death from botulism is swift

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and horrible for those who forget that the anaerobic bacterium *Botulinus clostridium* thrives in improperly heated and evacuated batches of canned food. Done properly, of course, canning is a blessing. Ever since François Appert invented canning in 1804 (in a 12,000-franc competition Napoleon held to promote the discovery of a good way to preserve fresh food), careful canning has benefited millions. Happily, moreover, for the tomatophile with an extra bushel on his hands, acid fruits do not produce botulism. The acid in the natural juices will, in conjunction with normal boiling, kill *B. clostridium* and other hungry little flora. Tomatoes, those paragons of acidity, can with great ease and safety.

The so-called cold pack method is very easy and leaves the tomatoes whole. First, wash both the tomatoes and your hands. Wash the jars, lids, and washers in hot, soapy water. Boil them in water to sterilize, for fifteen minutes, and leave them covered with the boiling water until you need them.

Blanch and peel the tomatoes. Pack them into the sterilized jars, leaving about one-half inch of headway. Push down lightly on the tomatoes as you pack them, filling the jars as tightly as possible. Add one teaspoon of salt to quart jars; one-half teaspoon to pint jars (salt also kills *Botulinus*). Run a knife around the side of the fruit to press out air bubbles. Press again on the tomatoes so that they are covered by their own juice.

Now seal the jars—carefully—for this is a fine art. Wipe the rims of lids and rubber rings clean. Moisten rubber rings just before sealing to insure a good fit. Then, seal the filled jars, but watch out. Each kind of jar requires a slightly different method.

Self-sealing Mason jars, which have two-part metal lids with a sealing compound on the bottom edge of the flat piece of the lid, should be sealed tight. They will still allow air to seep out during boiling and do not need to be tightened afterward. Mason jars with separate rubber rings should first be fully tightened, then loosened, by turning the lid back a quarter-inch, to let air out during processing. Tighten completely afterward. Wire-clamp-type jars should also be only partially tightened before boiling: pull the long wire down, but leave the short wire up. After processing, pull the short wire down for a complete seal.

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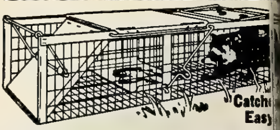

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Processing itself is almost as easy as boiling water. Completely immerse your properly sealed cold-pack tomato jars in hot water that has not quite boiled. Bring to a boil and keep it boiling. Process pints for 35 minutes, quarts for 45 minutes. Top up water level with more boiling water if necessary. Store finished jars in darkness.

Preserving tomatoes with sugar is even easier. Sugar is a preservative in its own right. The great simplicity and safety of this method is one reason that homemade jellies and jams never went out of style. Mireille Johnston's sophisticated tomato preserve (see below) comes from the south of France, but, minus rum, it is identical with traditional American tomato jellies and can be used with red and green varieties alike. In any of these recipes, of course, the original tomato is what counts. No taste gives no taste. Grow your own.

Red Tomato Preserves

(*Confiture de Tomates Rouges*, after a recipe in *The Cuisine of the Sun*, by Mireille Johnston.)

5 pounds local tomatoes
4 pounds sugar
Rind of 1 lemon
Juice of lemon
2 tablespoons dark rum (optional)

1. Hold the tomatoes, one by one, in simmering water for 5 seconds, to loosen the skins. Peel with a sharp knife and set each one aside as you finish with it, to cool.
2. Halve the tomatoes, squeeze out seeds, and place in a heavy-bottomed, nonaluminum saucepan. Stir in sugar, lemon rind, and lemon juice.
3. Bring to a boil, stir briefly with a wooden spoon, lower heat, and simmer for one hour or until the tomatoes have become transparent and sticky.
4. Remove the lemon peel, stir in rum, if desired, and then put the preserved tomatoes into dry, sterilized jars. Pour the syrup over them. Seal, with a layer of melted paraffin.

Serve with cookies or on toast, at tea or for a snack.

Yield: About 3 quarts.

Raymond Sokolov's most recent cookbook is The Saucier's Apprentice, *a guide to French sauces.*

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Announcements

Now that the Museum is open on Wednesday evenings until 9:00 P.M., visitors can enjoy an increased variety of activities. On August 24, three exhibition halls in the Museum will be enlivened by the performances of **Three Musical Groups.** At 6:00 P.M. the delicate sounds of panpipes will float through the Hall of Mexico and Central America as a trio called Tahuantinsuyu presents a concert of Andean music. The Mitchell Korn Ensemble will perform at 7:30 P.M. in the Hall of Pacific Birds. Korn plays a twelve-string guitar and composes his own imaginative pieces, which the ensemble performs with percussion instruments, a piano, a trumpet, and tapes of the sounds of nature. The last concert, at 8:00 P.M. in the Hall of Asiatic Mammals, will present Eastern music performed by Shyam Yodh playing the sitar, accompanied by a tabla and tamboura. All three concerts are free to those who have paid the Museum entrance fee.

Each autumn, thousands of birds of prey, which inhabit eastern Canada and the northeastern United States during the summer months, waft their way south for the winter in a massive and dramatic migration. Many make the journey by following the Appalachians, taking advantage of the updrafts offered by the ridges of the mountain chain. Most of the birds are broad-winged, red-tailed, or sharp-shinned hawks but the migration also includes ospreys, American kestrels, red-shouldered hawks, and some bald and golden eagles.

So close do the birds come to various outcroppings, cliffs, and peaks that there are several points along the Appalachians where man can virtually meet raptor. One of the most famous of these vantages is Hawk Mountain in central Pennsylvania, an S-shaped ridge which provides admirers of the migration an unsurpassed view of the birds.

On August 25, just before the height of the migration, the Museum will sponsor a slide show and film entitled **Birds of Prey of Nort North America.** The program w presented by James Brett, direc education at the Hawk Mou Sanctuary, who has observed th gration for the past thirty years program will be held in the au rium at 8:00 P.M., and is free tc ticipating and donor members c Museum. Tickets for associate r bers and the public will be avai at the door for $2 each.

During the weekend of Septe 17–18, the Museum will sponso largest **Anthropology Film Fes** ever offered to the general pu Held in honor of Margaret Mead rator emeritus of ethnology, who lier this year celebrated her birthday and her 50th year on the seum staff, the free event is desi to attract the broadest audience p ble. On view will be hundred films, ranging from those made i early 1900s to the latest release anthropologists and filmmakers.

The two-day event will offer tinuous screenings in eight diffe areas of the Museum—the au rium, the Education Hall, the Pe Center, and in five exhibition h Not only does the Museum's size itself to such a large undertaking its exhibits of the peoples and the vironments of the world provid ideal setting for this festival.

Speakers, including Dr. M will introduce the films, which wi followed by question and answer riods. The festival will include a t nical exhibit of camera and filmm ing equipment, a screening room members of the public who wan show their own films, and a scree area for children's films. A spe feature of the event will be even screenings of films by Jean Rou the noted French ethnographic fi maker. Mr. Rouch will be presen discuss his work and the art of mak ethnographic films. For further in mation regarding price of admiss and ticket availability for the even screenings call (212) 873-1300, tension 559.

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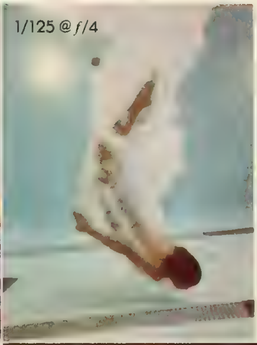

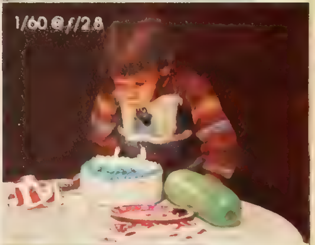

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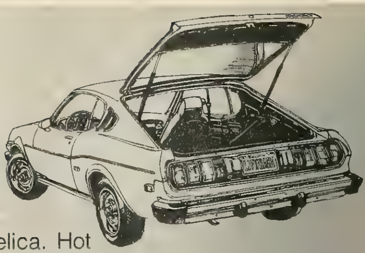
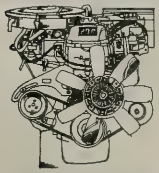
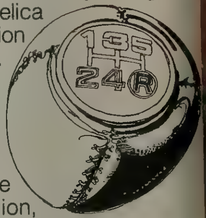


That's the 1977 Toyota Celica. Hot because of the way it looks, and the way it moves. Hot because there are three models, including the racy '77 GT Liftback. Hot because the Celicas are built with Toyota's famous toughness and durability. Their welded unitized-body construction eliminates body nuts and bolts to make them three of the most durable cars on the road.



Hot Performer. The '77 Celicas are powered by the revolutionary 20R engine—a 2.2 liter overhead cam design. Built from the ground up to give power, durability, and great gas mileage. In 1977 EPA tests the Celica GT with 5-speed overdrive transmission got 37 mpg highway, 22 mpg city. These mileage figures are estimates. The actual mileage you get will vary depending on your driving habits and your car's condition and equipment. California and EPA designated high altitude ratings will be lower.



Hot Items. A lot of hot features come standard on the 1977 Celicas. Like MacPherson strut front suspension, steel-belted radials, power front disc brakes, electric clock, tachometer, reclining bucket seats, tinted glass, and much more. We're proud of the '77 Celicas. In fact, we're proud enough to say, if you can find a better built small car than Toyota...buy it.

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1977 Celica GT Liftback
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Incorporating Nature Magazine
Vol. LXXXVI. No. 8
October 1977

American Museum of Natural History
Robert G. Goelet, President
Thomas D. Nicholson, Director

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Authors

Joseph B. Casagrande first learned of the intricate weaving of the Otavalo Indians when he began his field work in Ecuador in 1962. He has since returned to the country many times to continue his studies on the position held by Indians in Ecuadorean society from colonial times to the present. His research has also taken him to Spain, where he scoured various archives for information on Spanish attitudes toward the Indians. A professor of anthropology at the University of Illinois in Urbana, Casagrande is currently studying the recent conversion from Catholicism to Protestantism among Indians of a number of Ecuadorean highland communities.

The science of the upper amosphere has been **Raymond G. Roble**'s field of interest throughout his working life. He has been with the National Center for Atmospheric Research in Boulder, Colorado, since 1969, the year he earned a Ph.D. in aeronomy from the University of Michigan. His current research involves modeling the meteorology of the atmosphere above sixty miles. Future projects include an investigation of the effects of the aurora on the upper atmosphere. Living in Boulder makes it possible for Roble to indulge in all his hobbies — mountain climbing, backpacking, and skiing.

"When I was working on my bo
Men, Beasts, and Gods: A History
Cruelty and Kindness to Animals," s
Gerald Carson, "I began to consi
the interaction between men and a
mals when war comes to mod
nation-states. This led to an investi
tion of the situation in Paris during
siege of 1870–71, when even the
animals were eaten." Result: t
month's article. Carson, who began
career in the advertising field, has b
an author and social historian for
past twenty-five years. A frequent
viewer of books for *Natural Hist*
this is his fourth article for the ma
zine.

"If you're like me, you probably think that taking really good pictures is very difficult . . . that it must take a lot of skill and very expensive camera equipment. You know, like those professionals you always see with their 35mm Nikon cameras.

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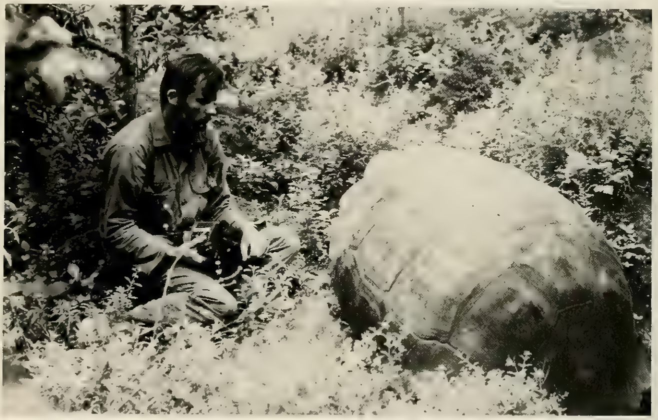
Peter M. Knudtson combines seasonal work as a wildlife biologist with free-lance nature writing and photography, some of which has been published in *Natural History*. He wrote about Wintu culture ("Flora, Shaman of the Wintu") in May 1974, and the social behavior of harbor seals (Birth of a Harbor Seal") in May 1975. During the winter of 1976, he spent three months traveling in Central America, and witnessed the February 4 earthquake in Guatemala. He devoted part of that trip to a search for the rare Caribbean monk seal, generally believed to be extinct. Having recently returned from Prince William Sound and southeastern Alaska, where he worked as a wildlife biologist for the U.S. Fish and Wildlife Service, Knudtson describes his future plans as "more travel, more writing, more study."



"A scientist who aspires to a pur
of science that is adventurous and est
tic as well as rigorous," is the v
Peter C.H. Pritchard describes h
self. In pursuit of his aspiration,
English-born zoologist has done f
work in the southern United Sta
Iran, Guyana, Surinam, Mexico, H
duras, Peru, Micronesia,
Galápagos Islands, and earlier
year, Venezuela, where he studied
habits, distribution, and classificat
of that country's turtles. Pritcharc
vice-president for science and resea
of the Florida Audubon Society,
has served as a special investigator v
the sea turtle specialist group of
International Union for the Conser
tion of Nature.

While working on his master's project, which concerned embryonic chick limb development, it was proposed to **Richard B. Borgens** that naturally produced electrical current might be the control of limb regeneration. He found the notion fascinating and his curiosity was, as he says, "permanently aroused." Now a postdoctoral research fellow at Purdue University, he is continuing his research into the endogenous electrical controls of amphibian regeneration, specifically investigating what the cellular target of the regeneration currents (in salamanders) might be. Borgens feels that there is good evidence for the assumption that internally produced electricity plays a role in the replacement of tissues, and of wound healing in general, in *all* vertebrates.

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The Hazards of Coal Dependence

by Wallace S. Broecker

If coal becomes our main source of energy, excess carbon dioxide in the atmosphere may inadvertently cause major climatic changes

As global oil reserves dwindle, we struggle with the problem of deciding on our next major energy source. The utopia of a world powered by light from the sun lies, perhaps, a century in the future. Fusion power awaits an even greater number of technical advances. Hydropower, wind, tidal, and geothermal power are destined for secondary roles. There is no way to obtain the amount of energy we will need from any one or combination of these sources. This leaves coal and uranium as the only stopgap energy sources for the period between the demise of petroleum and the onset of large-scale use of solar power. Despite the rape of the land and the toll of life accompanying the recovery of coal, and despite the host of environmental poisons released during its combustion, it is the current front-runner. The threats of catastrophe resulting from reactor malfunction, sabotage, or nuclear weapons manufactured from reactor byproducts has turned a sizable segment of society against nuclear power.

In this debate over energy sources, one aspect of the problem has received relatively little attention. Burning the world's coal reserves will produce about eight times the carbon dioxide (CO_2) currently in the atmosphere. In order to see our way through to the era of solar power we will almost certainly have to burn enough of these coal reserves to double the atmosphere's CO_2 content. Once in the atmosphere, this CO_2 will linger for hundreds of years before being removed to the sea, a second reservoir for CO_2. During this time the earth's climate, and therefore its ecology, will be quite different from that of today. As there is no practical means of capturing the CO_2 produced during
the combustion of chemical fuels
coal economy will inevitably lea
higher atmospheric CO_2 content an
consequent environmental chan
Thus, before we take actions that
lock us into bequeathing to the g
erations to follow a millennium of w
I believe will be a warmer climate,
had better learn more than we
know about life in this "superinter
cial" world.

I say superinterglacial because o
the last million or so years the clim
of our planet has swung back and f
between intervals of relatively c
conditions, called glacials, and r
tively warm conditions, called inter
cials. For the last ten thousand years
have been in one of the intergla
intervals. The addition of large qu
tities of CO_2 to the atmosphere
probably push the earth's climate in
realm considerably warmer than
experienced during the last several
terglacials. In this sense, the p
coal-burning era will be a superin
glacial.

The fossil-fuel-derived CO_2 we
lease into the air will make itself
through its ability to capture infra
light being given off by the earth.
often used analogy between our atm
phere and a greenhouse, although
perfect, is apt. Just as glass panes all
sunlight to enter a greenhouse
greatly impede the loss of heat, so C
transmits incoming sunlight but
pedes the passage of outgo
earthlight. The white-hot sun sends
high-frequency, visible radiations t
cannot be intercepted by CO_2. The re
tively cool earth gives off low-
quency, infrared radiation that can
intercepted by CO_2. The human ins
tion of extra CO_2 between the eart
surface and the sun will, accordin
alter our planet's radiation balance.
earth adjusts its energy budget to
required state, in which the amount
energy lost daily just matches
amount of energy gained, primarily
means of temperature change.
higher the temperature of an object,

He sacrificed his sanity and his life to see and to paint as no one ever had before

The World of Van Gogh

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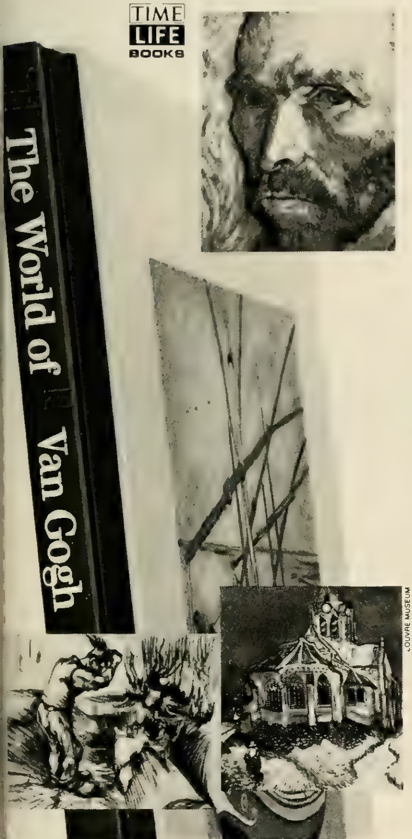
The World of Van Gogh

LOUVRE MUSEUM

HE TRIED to express his feeling for man and nature by becoming a minister, but his fervor alarmed his superiors. He fell in love with two women of his own class and they fled from him as from a dangerous lunatic. The famous incident in which he cut off part of his ear and gave it to a prostitute was only one more attempt to give something of himself to anyone who would accept it.

This torrent of emotion—for which society had no use—turned Vincent Van Gogh into one of the greatest painters of all time. Never has a man poured so much pure responsiveness into his art. You can see in it everything from salvation to suicide. Sacrificing his life and sanity to his work, he burned himself up in a blaze of perception, a controlled riot of color that washed over modern art like a tidal wave of lyricism.

Love, for Van Gogh, was a means of seeing...of fusing himself with his subjects. Even the lavish way he squeezed a tube of paint directly onto his canvas symbolized a generosity that knew no limits. To the humblest subject—an old pair of boots, an empty chair—he brought the special light of his own fervor. As one critic put it, Van Gogh had the courage to look the sun squarely in the face and steal its radiance.

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City____________State or Province____________Zip or Postal Code________ more heat (infrared light) it emits. Thus, by trapping the outgoing infrared radiation, the primary effect of more CO_2 in the earth's atmosphere will be a warmer planet.

Associated with a global warming will be a host of climatic side effects. Among these, one of the most important will undoubtedly be a change in the pattern of rainfall on the earth's surface. Some regions will get more rain than they now do; others will get less. This, in turn, will affect the ability of a given area to grow food. Somehow, we must determine in advance of a global warming what these regional changes will be and evaluate their effects on the web of activity that allows our planet to support so many human beings.

There are two different ways in which this might be done. One would be to wait until the warming induced by increased CO_2 becomes perceptible and then make a direct calibration of its effects. Such a calibration will only become possible when CO_2 has moved the climate well beyond the range of natural variability. Unfortunately, by then the die will have been cast. As no substantial change in our energy supply can be made in less than about fifty years, this empirical evaluation of environmental hazards must remain a last-ditch backup.

The only before-the-fact method of assessing the effect of increased CO_2 is by atmospheric modeling. To do this, a mathematical simulation of all the important processes occurring in the system is constructed. With the aid of large computers, this model atmosphere is perturbed by the addition of CO_2. The changes in the climate of the model atmosphere are then taken as indications of those of the real atmosphere.

The problem is to make a realistic simulation. This is difficult for two major reasons: even the largest existing computers are too small to duplicate the atmosphere in sufficient detail, and we do not adequately understand some of the physical processes operating on the earth's surface. Shortcuts and simplifications must be introduced into the models; consequently, the applicability of the model's results to the real atmosphere remains in question.

At present, about the only useful piece of information that can be obtained from these models is an estimate of the change in mean global temperature associated with a given change in atmospheric CO_2 content. Although falling well short of our real need for regional estimates of variables, such as temperature, rainfall, and wind speed, such a calculation can tell us whether we are dealing with a change of major consequence. Before stating why this is so, let us first see what the magnitude of the temperature change will be.

Based on the models currently in use, the consensus seems to be that for each doubling of the CO_2 content of the atmosphere, the mean earth temperature will rise by about four degrees fahrenheit. Thus, if we raise the atmospheric CO_2 content from its preindustrial value of 295 molecules of CO_2 per million molecules of air to 590 parts per million (ppm), the planetary temperature will rise from its current mean of 60° F to about 64° F.

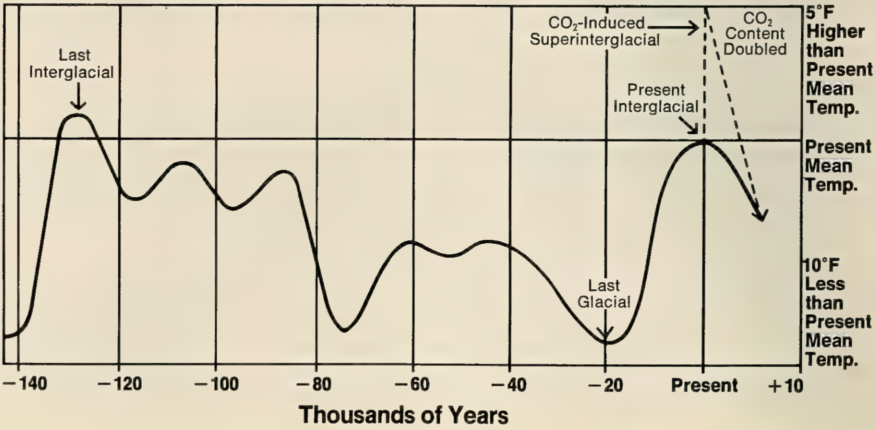
The main concern with the validity of this result has to do with the manner in which cloud cover is handled by the models. In the absence of greater computational capability and of an adequate knowledge of cloud physics, the modelers have been forced to hold the earth's mean cloud cover fixed at the current average value. The modelers are fully aware that the mean cloudin will change with rising CO_2 conte but it is not possible at present to with certainty whether it will incre or decrease, let alone foretell how the change will be.

Clouds reflect back into space so of the incoming sunlight that stril them. If rising CO_2 levels enhance extent of cloud cover, then the eart extra reflectivity will partly compens for the excess infrared capture and planet will not warm as much in sponse to added CO_2 as predicted by models currently in use. On the otl hand, were cloudiness to decrease, opposite would take place: less sunli would be reflected and the earth wo get even warmer than predicted.

At present there is no way to det mine even the sign of the cloud effe let alone by how much it will alter current global temperature-change timates. As much as a decade will p before even preliminary estimates the importance of cloud cover char can be made.

(Please turn to page

The solid curve shows the record of the mean global temperature over the last 140,000 years, as reconstructed from paleoenvironmental information, and the expected future trend in the absence of any human interference. The dashed line shows the trend expected if we double the CO_2 content of the atmosphere through the burning of fossil fuels during the next century.



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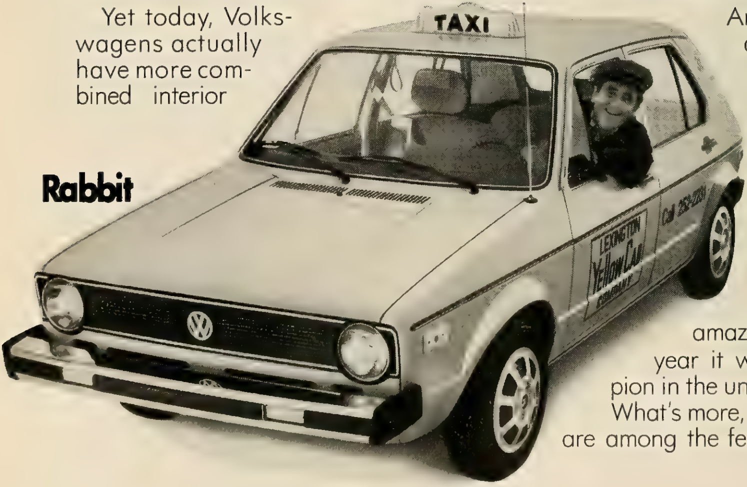

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The absence of the capability to generate clouds in computer models also prevents modelers from estimating the changes in regional rainfall. As this information is absolutely essential to any evaluation of the effect of enhanced CO₂ levels on the ecology of "wild" plant communities and on agricultural productivity, the forecasts we need cannot be made until this hurdle is surmounted. Thus, all possible efforts must be made to speed research in this area.

In the meantime, we will have to live with the estimate that if through the burning of chemical fuels we double the CO₂ content of the atmosphere, this doubling will lead to a four degree rise in the mean temperature of our planet. What effect will this have on the earth's environment? From the point of view of personal comfort, the answer may well be, not much. There might be fewer opportunities for skiing but more for swimming. This approach, however, proves to be extremely misleading. It is not personal comfort that is at stake, but the state of the whole web of life—the ecosystem. Plants are sensitive to the amount of rainfall, the intensity and timing of frost, the speed of the wind. Animal life is ultimately geared to the food provided by plants.

I know of only one method that might indicate the effects of the coming warming on the ecosystem and that is examination of past times during which the earth's temperature was different from that of today. Global climate, when averaged over several decades, has remained remarkably constant during historic time. We have experienced no prolonged period when the earth as a whole was much warmer or much colder than it is now. Since the present interglacial has persisted for the last ten thousand years, we have to go back well beyond the beginning of written records to find a time when climate was quite different.

Between ten and thirty thousand years ago, the earth was immersed in one of its glacial periods. Because we know of no time in the last million years when the earth was much warmer than during the present interglacial, we will have to make do with what we can learn from the changes associated with the warming that took us from that last glacial to the conditions that have prevailed during historic time. Fortunately, nature keeps her own records and has preserved the information we need to reconstruct the environmental changes that took place during that transition.

Sediments preserved on the sea floor,
for example, carry a wealth of inform
tion regarding past climates. From t
hard parts of microscopic plants a
animals found in abyssal muds, scie
tists have been able to reconstruct t
surface-water temperatures over t
last million years. The astounding r
sult of oceanwide research t
CLIMAP (Climate/Long-Range I
vestigation, Mapping, and Prediction
comparing deposits formed during t
last glacial period with those forme
during the current warm epoch, is th
the oceans are, on the average, on
about four degrees warmer now th
they were then.

Continuous records are contained
the slowly accumulating ice of t
"highlands" of Greenland and Antar
tica. Changes in the air temperature
these regions can be reconstructed fro
ice cores recovered in long borin
through these polar caps. This record
kept by the isotopes of oxygen in the i
itself. The colder the air, the more d
pleted in the "heavy" isotope of oxyge
are the snow flakes that form in clou
over the icecap (and hence, the ice u
timately formed on the cap below
These isotopic temperatures tell us th
the polar regions were only abo
twelve degrees cooler during full gl
cial times than they are today.

Finally, sediments in bogs and lak
bear pollen grains blown in from t
surrounding terrestrial vegetation. T
relative abundances of pollen from di
ferent plants are clues to the ecology
the adjacent lands. In a number of spo
on the globe these clues indicate t
degree to which the temperature in t
continental interiors changed betwe
glacial and postglacial time. The
values show quite a range, and sugge
that the continents warmed from 10°
to 30° F at the close of the last ice ag

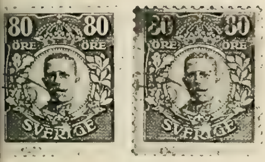
With the help of computer model
this information has been pieced t
gether to yield a global average tempe
ature difference between peak glaci
time (twenty thousand to sixte
thousand years ago) and peak intergl
cial time (six thousand to thr
thousand years ago). The result tur
out to be only nine degrees. Thus, if t
CO₂ we generate warms the earth
four degrees, we will have succeeded
making a change about half as large
the one that occurred when the great i
sheets covering virtually all of Sca
dinavia and Canada shrank to oblivi
at the close of the last glacial period.
the environmental changes associat
with the transition from the present i
terglacial to the CO₂-induced supe
interglacial are half as great as tho

On Photographing the Invisible

To the naked eye, it was a Swedish 80-ore postage stamp. A rarity, and ry valuable.

The camera, however, told quite other story. The stamp was a coun- feit.

Faint traces of tampering that were lden to the naked eye were revealed the camera. Someone, somewhere, d ingeniously altered the stamp by emically removing a surprint. The mp was worthless.



To the naked eye (left), the stamp was genuine. To the camera (right), it was a counterfeit. Note the faint, dark traces of tampering now revealed in the upper section.

What manner of exotic camera s this that could "see" the invisible?

The lens: one of the 20 in the isselblad arsenal, the 105mm Zeiss V-Sonnar f4.3. Designed for pho- graphy within the ultraviolet portion the electromagnetic spectrum, its stly quartz elements can detect liations that are unseeable by the man eye.

It has peered at objects in outer ice, examined forgeries, laid bare secrets of counterfeit money. Not ens for everyone, obviously, but an lication of just how awesomely com- hensive the Hasselblad System is.

The camera: an otherwise per- tly standard Hasselblad 500C/M, normally fitted with an 80mm Zeiss Planar f2.8 multi-coated lens.

This is the basic model that allows you to tap into the vast Hasselblad System. It is one of the most bewilderingly versatile cameras the world has ever known. Yet so marvelously simple to operate that it often plays the part of the family snapshot camera.

A True System.

The Hasselblad System is a prodigious array of 4 cameras, 20 lenses, 8 viewfinders, 9 film magazines, and over 300 other accessories. Choose the right pieces, and your 500C/M would be equipped for sports, aerial, architectural, and fashion photography.

And portrait, landscape, medical, underwater, and news photography.

And wildlife, laboratory, industrial, and child photography.

And you would always have the right film in the camera at the right time. You can shift from color to black-and-white and back again to color—and resume shooting at precisely the right frame—by popping in the protective dark slide and switching film backs.

The Camera with Nine Backs.

There is a small button on the film back of every Hasselblad 500C/M. Slide it sideways with your thumb and the back will come away in your hand.

The standard back holds 12 exposures. Each frame of film is 2¼ inches square, *almost four times the area of a 35mm frame.* (See box, below right, for actual size.)

This is only the beginning. There are eight other backs available: Backs that let you change to a 6 x 4.5cm format...or a 4.5 x 4.5cm superslide format for showing in any 35mm projector. Backs that give you a choice of 1, 12, 16, 24, 70, or 500 exposures. A back that is a sheet-film adapter. Even two backs for Polaroid film, so you can check composition, lighting, and exposure ahead of time.

You begin to realize why eight out of ten top commercial photographers surveyed name Hasselblad as the medium-format camera used in their work.

Retained Value vs. Obsolescence.

In an age when machines spew out cameras in the tens and hundreds of thousands, when flashy new models thrust last year's marvels into early obsolescence, Hasselblad goes its own way.

Planned obsolescence is taboo at Hasselblad. All but two of the accessories for the 500C/M will fit every Hasselblad made since 1957 (except the Super Wide C)...and will fit every future Hasselblad.

The greater part of a year is spent on building each camera, much of it crafted by hand. And fully one quarter of the work force devotes its time to nothing but quality control.

Little wonder, then, that a pre-owned Hasselblad commands such a high price...if its owner can be persuaded to part with it at all.

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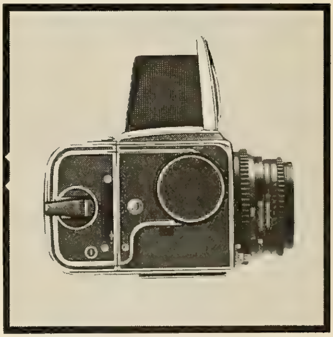

The Hasselblad 500C/M.

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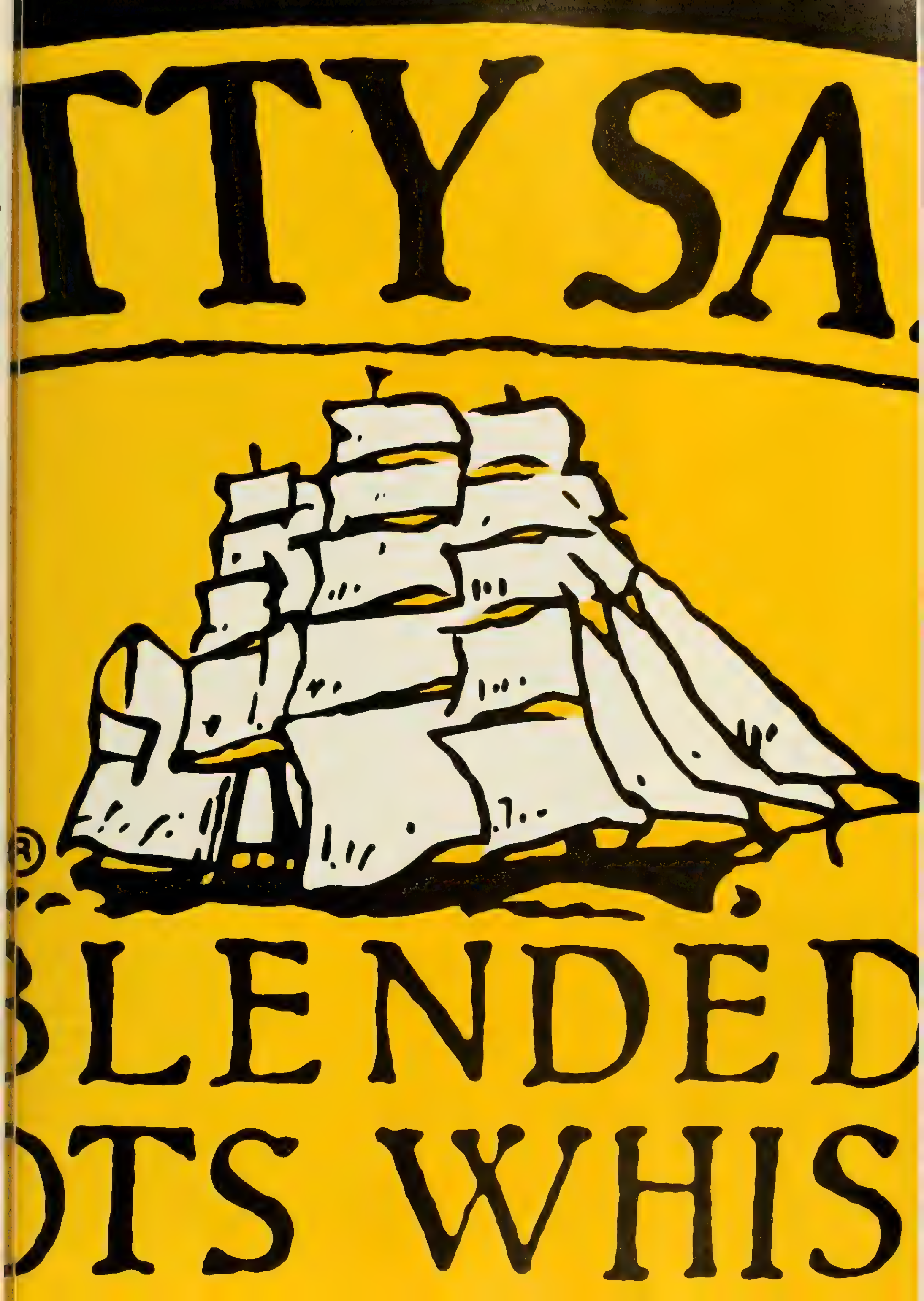
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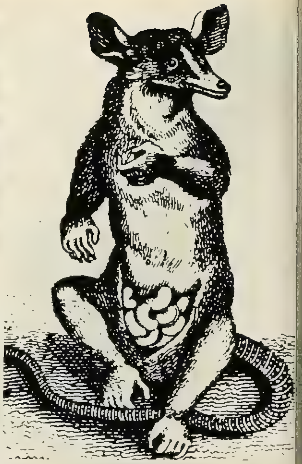

very terms of our taxonomy reinfo this prejudice. All mammals are vided into three parts: the egg-layi monotremes are called Prototheria, premammals; placentals win the pr as Eutheria, or true mammals; the p marsupials lie in limbo as Metather or middle mammals — not all qu there.

The argument for structural in riority rests largely upon differ modes of reproduction in marsupi versus placentals, bolstered by usual smug assumption that differ from us is worse. Placentals, as know and experience, develop as e bryos in intimate connection wit mother's body and blood supply. W some exceptions, they are born as r sonably complete and capable cr tures. Marsupial fetuses never dev oped the essential trick that permits tensive development within a moth body. Our bodies have an uncar ability to recognize and reject fore tissues, an essential protection aga disease, but a currently intractable b rier to medical procedures ranging fr skin grafts to heart transplants. Des all the homilies about mother love, the presence of 50 percent mate genes in offspring, an embryo is foreign tissue. The maternal imm system must be masked to prevent jection. Placental fetuses h "learned" to do this; marsupials h not.

Marsupial gestation is very shor twelve to thirteen days in the comn opossum, followed by sixty to seve days of further development in the ternal pouch. Moreover, internal velopment proceeds, not in intin connection with the mother,

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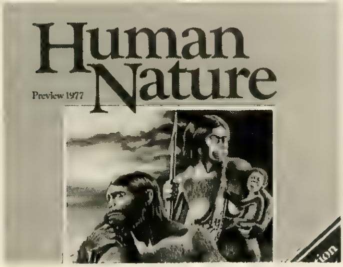

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shielded from her. Two-thirds of gestation occurs within the shell membrane, a maternal organ that prevents the transfer of lymphocytes, the "soldiers" of the immune system. A few days of placental contact follow, usually via the yolk sac. During this time, the mother mobilizes her immune system, and the embryo is born (or, more accurately, expelled) soon after.

The marsupial neonate is a tiny creature, equivalent in development to a rather early placental embryo. Its head and forelimbs are precociously developed, but the hind limbs are often little more than undifferentiated buds. It must then undertake a hazardous journey, slowly pulling itself along over the relatively great distance to the mother's nipples and pouch (we can now understand the adaptive necessity of well-developed forelimbs). Our embryonic life within the placental womb sounds altogether easier and unconditionally better.

What challenge can then be offered to these biogeographical and structural accounts of marsupial inferiority? John A. W. Kirsch has recently marshaled the arguments in the May-June 1977 issue of *American Scientist*. Citing the work of P. Parker, Kirsch contends that marsupial reproduction follows a different adaptive mode, not an inferior path. True, marsupials never evolved a mechanism to turn off the maternal immune system and permit a completed development within the womb. But early birth may be an equally adaptive strategy. Maternal rejection need not represent a failure of design or lost evolutionary opportunity; it may reflect an ancient and perfectly adequate approach to the rigors of survival. This argument goes right back to Darwin's central contention that individuals struggle to maximize their own reproductive success, that is, to increase the representation of their own genes in future generations. Several highly divergent, but equally successful, strategies can be followed in (unconscious) pursuit of this goal. Placentals invest a great deal of time and energy in offspring before their birth. This commitment does increase the chance of an offspring's success, but the placental mother also takes a risk: if she should lose her litter, she has irrevocably expended a large portion of her life's reproductive effort for no evolutionary gain. The marsupial mother pays a much higher toll in neonatal death, but her reproductive cost is small. Gestation has been very short and she may breed again in the same season. Moreover, the tiny neonate has not placed a great drain upon her energy budget and has subjected her to little danger in a quick and easy birth.

Turning to biogeography, Kirsch challenges the usual assumption that Australia and South America were refugia for inferior beasts that couldn't hang on in the placental world of the Northern Hemisphere. He views their southern diversity as a reflection of success in their ancestral homeland, not as a feeble effort in peripheral territory. His argument relies upon M. A. Archer's claim for close genealogical relationship between borhyaenids (South American marsupial carnivores) and thylacines (marsupial carnivores of the Australian region). Taxonomists have previously regarded these two groups as an example of evolutionary convergence — separate developments of similar adaptations (as in the marsupial and placental saber-tooths, mentioned previously). In fact, taxonomists have viewed the Australian and South American radiation of marsupials as completely independent events, following the separate invasion of both continents by primitive marsupials pushed out from northern lands. But if borhyaenids and thylacines are closely related, then the southern continents must have exchanged some of their products, probably via Antarctica. A more parsimonious view imagines an Australian center of origin and a dispersal to South America following the evolution of thylacinids, rather than two separate marsupial invasions of South America —borhyaenid ancestors from Australia and all the others from North America. Although the simplest explanations are not always true in our wondrously complex world, Kirsch's arguments do cast considerable doubt on the usual assumption that marsupial homelands are refugia, not centers of origin.

Yet I must confess that this structural and biogeographic defense of marsupials falters badly before one cardinal fact, prominently featured above: the Isthmus of Panama rose, placental carnivores invaded, marsupial carnivores quickly perished, and the placentals took over. Does this not speak for clear competitive superiority of the North American placental carnivores? I could sneak around this unpleasant fact by ingenious conjecture, but I prefer to admit it. How then can I continue to defend marsupial equality?

Although the borhyaenids lost big, I find no scrap of evidence to attribute defeat to their status as marsupials. I prefer an ecological argument predicting hard times for any indigenous gr
of South American carnivores, ma
pial or placental. The real victims h
pened to be marsupials, but this ta
nomic fact may be incidental to a
sealed for other reasons.

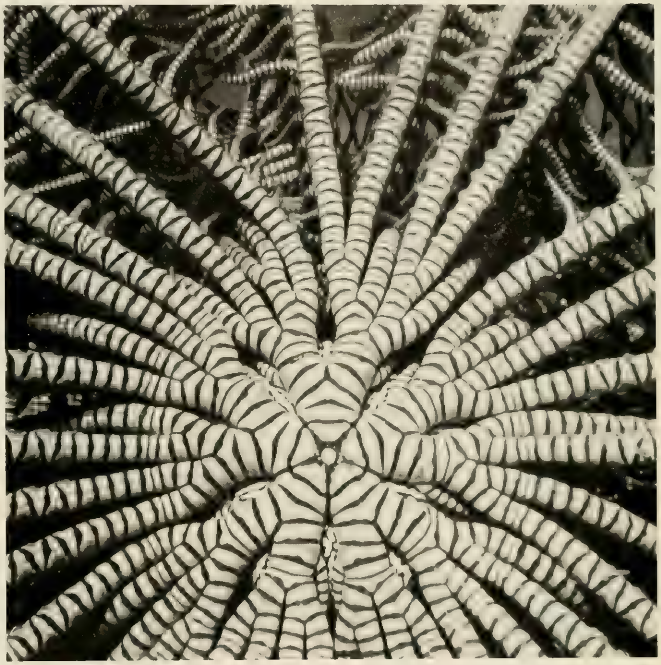
R. Bakker has been studying the
tory of mammalian carnivores throu
out the Tertiary. Integrating some r
ideas with conventional wisdom,
finds that the northern placental ca
vores experienced two kinds of e
lutionary "tests." Twice, they suffe
short periods of mass extinction,
new groups, perhaps with grea
adaptive flexibility, took over. Dur
times of continuity, high diversity
both predators and prey engendered
tense competition and strong e
lutionary trends for improvement
feeding (quick ingestion and effici
slicing) and locomotion (high accele
tion in ambush predators, enduranc
long-distance hunters). South Am
can and Australian carnivores w
tested in neither way. They suffered
mass extinctions, and the original
cumbents persisted. Diversity ne
approached northern levels, and co
petition remained less intense. Bak
reports that levels of morphologi
specialization for speed and ingest
of carcasses lie far below those
northern carnivores living at the sa
time.

H. J. Jerison's studies of brain s
provide an impressive confirmati
On northern continents, placental pr
ators and prey evolved successiv
larger brains throughout the Tertiary
South America, both marsupial ca
vores and their placental prey quic
plateaued at about 50 percent of br
weight for average modern mammal
the same body sizes. Anatomical sta
as marsupial or placental seems to m
no difference; a relative history of e
lutionary challenge may be crucial.
by happenstance, northern carnivo
had been marsupials and southern c
nivores placentals, I suspect that
outcome of isthmian exchange wo
still have been a rout for South Am
ica. North American faunas were c
tinually tested in the fiery furnaces
mass destruction and intense comp
tion. The South American carnivo
were never strongly challenged. Wh
the Isthmus of Panama rose, they w
weighed in the evolutionary balance
the first time. And like Daniel's ki
they were found wanting.

Stephen Jay Gould teaches biolo,
geology, and the history of science
Harvard University.

rinoids are beautiful even in black-and-white.

ctually, you wouldn't be able to see here the difference between odachrome film and the new Kodak Ektachrome films.



B. Macurda, Jr. of the University of
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anced speed and contrast. If you'd
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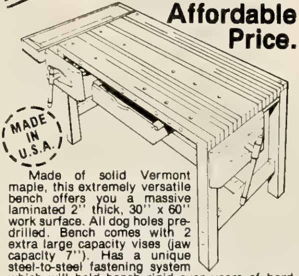

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* Egyptian Cat — Louvre, Paris

by Robert S. Desow

Harmonious Parasites

Some of the common diseases of industrialized societies may be countered by those of developing societies

Those of us engaged in teaching parasitology to medical students usually present a Grand Guignol pictorial display of the more devastating effects of our favorite pathogens. This show business technique helps keep students awake in a course that might otherwise not rate too highly in the curriculum popularity polls. Even students who want to be psychiatrists (perhaps especially these students) rarely fail to respond empathetically to a photograph of the grotesque testicular enlargement caused by filarial elephantiasis. The initial impression is that parasites are inevitably malevolent.

While the balance sheet would show that parasites undoubtedly do more harm than good, recent research has brought to light some curious and intriguing examples of parasitic infection that may contribute to the total health of the host. These are not merely oddments in the biological curiosity cabinet. The phenomenon of the harmonious parasite has greater import.

Modern medicine now appreciates, or rather reappreciates — since the concept goes back to the ancient Greek founding fathers of medicine—that a causal relationship exists between the nature of our ailments and the character of the ecosystem in which we live. The unhappy affairs of the heart in industrialized countries are well known, as are the infectious diseases associated with primitive agriculturists in the tropics. We ten think of these societies and their ill worlds apart, but the emerging ture from natural and experimen observations reveals a dynamic b ance in which the diseases of one ciety can actually suppress those another.

While the primitive and poor of tropical world may be wanting in tomobiles, televisions, washing chines, and clothes dryers, they g erally enjoy a freedom from hyp tension and the cardiac problems s fered by more civilized, affluent cieties. Not only is abnormally h blood pressure conspicuously abs in these areas but blood pressure d not rise with increasing age as Westernized, urban populatio Several explanations have been fered for this, such as diet and a m of life without stress. Undoubte these are important factors, but t have not convinced some investi tors as being the complete story.

Studies conducted in a region New Guinea where malaria hyperendemic concluded that disease, as well as other chronic fectious diseases, causes a lower of blood pressure. In one investi tion, the blood pressure of adults w enlarged spleens—a hallmark of laria—was compared with that of dividuals from the same village w had normal spleens. The group w the big spleens had both lower sys lic and diastolic pressures than the affected individuals. Similar res were reported by a research team the Papua New Guinea Institute Human Biology, which studied communities: one living in the hu

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s match-needle or electronic auto-exposure con- best? Minolta offers both, so our only concern is t you get what's best for you.

ienerally a match-needle camera costs less. To set osure, you line up two needles in the viewfinder. It's y, fast and accurate, but you do the work. Minolta -T match-needle cameras offer a wide variety of tures and prices.

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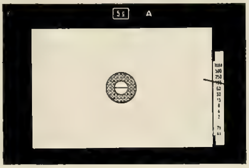

Vhat should I look for he viewfinder? First of a bright image. So you see clearly and focus ily. Judge this by com- ing several brands un- the same light condi- is.

hen, exposure information. The more the view- ler shows, the more you know about how the camera aking the picture. If this means a lot to you, pay the a cost. If not, save on a simpler camera.

he important thing about Minolta SLR's is that in ry single one, you can compose, focus, set expo- e and shoot without ever looking away from the vfinder. So you won't miss shots of even the fastest- ving subjects.

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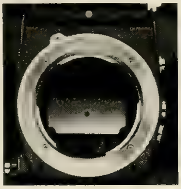

7. How fast can I change lenses? You shouldn't have to miss shots. So Minolta developed and patented a bayonet mount that lets you change lenses with less than a quarter turn. And unlike other bayonet mounts, Minolta's doesn't require you to realign f/stops afterwards.

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9. How should it sound? Press the shutter button. Noisiness means either vibration or inadequate damping of moving parts. Or both. The newest Minolta shutters are a joy to hear because you almost can't hear them at all.

10. How do I judge craftsmanship? Compare. Everything should be tucked in neatly. Finishes should be even and unmarred. No machining marks should be visible, even inside the camera.

11. What is the camera's reputation? Be sure to ask friends about Minolta. Since it's the best-selling imported camera brand in the U.S., chances are someone you know owns one.

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lowlands where malaria transmiss is intense; the other in the highla where lower temperatures inhibit development of the malaria paras in the mosquito vector. No one kno how malaria and other chronic inf tious diseases lower blood pressu With further research, scienti might be able to reproduce the effe without the infection, thereby alle ating the problem of hypertensi in industrialized societies.

The heart attack, the civilized w of death, rarely occurs in the less phisticated societies of the tropi world. High blood pressure and hi blood cholesterol are the notori factors implicated in coronari Again, the malaria parasite may prophylactic, for it not only low blood pressure but also appears to crease cholesterol level.

Some years ago my colleagues a I carried out experiments to det mine the long-term pathophysiolo cal consequences of malaria in p mates and rodents. One of the f consistent alterations in blood che istry that we observed was the p found decrease in the amount serum cholesterol in the infected a mals. There was no precise und standing of the mechanism involv but we hypothesized that the paras either affected the cholesterol-p cessing tissues, notably the liver, consumed the serum cholesterol its own metabolic needs.

Still another possible beneficial sult of the malaria parasite is its in ence on the immune response. highly activated does the response come in attempting to mount a fense against the parasite that imn nity to certain other antigens may depressed. In some circumstan this is undoubtedly harmful. Child with malaria, for example, do not spond to immunization against te nus as well as do uninfected you sters. Another example is that of immune response to Burkitt's ly phoma—a form of cancer of lymph system. Researchers have p tulated that this cancer is caused a virus that the immune system usually suppress. The presence of malaria parasite, however, m depress the immune surveillance s tem to such an extent as to allow proliferation of the lymphoma vir

On the credit side of the bala sheet, however, there is evidence t malaria prevents autoimmune eases, such as lupus erythemato and inflammatory conditions, such at scourge of the temperate zones, eumatoid arthritis. Remarking on e rarity of these conditions in the ndemic malaria zones, epidemio- gists have pointed out the apparent nportance of environmental factors ither than genetic predisposition. /hile the autoimmune and inflam- atory diseases rarely occur in West fricans, American blacks of West frican origin incur these conditions ore frequently than do white Ameri- ans. Researchers have thus directed eir studies toward environmental ctors, but they have not by any eans explored the role of parasites.

To date, only a few experimental ials have tested the hypothesis that alaria suppresses autoimmune dis- ses. Two British scientists, B. M. reenwood and A. Voller, however, d conduct one investigation. They tained a strain of mice that sponta- ously developed autoimmune kid- y disease and infected these ani- als with a rodent malaria, *Plasmo- um berghei*. In their results, the un- fected control mice developed se- re renal disease and died while the alaria-infected animals (once the rasite infection had been resolved self-cure) remained alive and well. e two researchers did not discover e manner in which the mice were otected from autoimmune renal dis- se but suggested that the implica- ns of their research might carry er to the treatment of such diseases humans.

The benevolent effect of parasites their victims is not limited to ma- rial infection. The lowly, ill- garded intestinal worms may also ve a beneficial quality. These para- es may act as antagonists in pre- nting certain pathological condi- ns of high prevalence in sanitized, rm-free populations. Undoubt- ly, the most striking of these rela- nships is that between worms and ergy. Epidemiologists have noted at allergies such as hay fever and pol- asthma are rare in wormy pop- ations. Immunological theories on causes of allergy and the elegant periments of R. C. Godfrey and C. F. aidige in England have created a per- asive hypothesis to account for this enomenon.

Allergic reactions are caused by production of a special class of tibody known as IgE, or reagenic tibody, in response to myriad aller- ns such as pollens, foods, and even mites in house dust. IgE has the ique property of attaching itself to specific receptor sites on the membranes of histamine-rich cells of the body called basophils and mast cells. Through a series of reactions, still not entirely understood, disruption of the cell with the release of histamine and other allergy-inducing substances occurs when the antigen (allergen) specifically bridges two adjacent antibody molecules projecting from the cell surface.

The manner in which the helminth parasites, or worms, prevent this immune reaction is indeed curious since helminths are even more potent stimulators of IgE than pollen and other allergens. In fact, it is this very immunogenic potency that accounts for inhibition of the allergic process. The IgE level in asthmatic patients averages about 400 units per milliliter of serum. The level in humans with worms averages 1,000 units, with concentrations of 5,000 units per milliliter or even higher. Quite simply then, the amount of IgE produced by the presence of worms is overwhelming, occupying most of the receptor sites on the cell. The IgE produced in response to pollen or other allergens has no place to go.

The paradox in this sitution is that in these parasitic infections there is no hard evidence that the "worm" IgE antibodies provoke reactions as they do in allergic patients. The reason for this difference remains a mystery. Hypotheses abound, but no convincing experimental evidence has come forth. Nevertheless, insights into the mechanism are of obvious importance in developing a treatment for those who suffer allergies.

Even that vampire of the intestinal tract, the hookworm, deserves some consideration. Hookworms cause an iron deficiency anemia, but if the worms' toll is not too high and iron intake from food sources adequate, the anemia is not so severe as to be markedly deleterious.

Admittedly, chronic anemia cannot be advanced as a sign of blooming health, but even so, it may have a beneficial effect, still another example of the exquisitely balanced give-and-take between infections. People with worm-induced iron deficiency anemia are particularly resistant to bacterial infections. Only anemia of this type confers such protection. Patients with anemias arising from impaired function of the tissues that manufacture red blood cells or hemolytic anemias, which destroy red blood cells, such as occurs in

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sickle-cell anemia, appear to be fully susceptible to bacterial pathogens.

Some researchers have speculated that since many bacteria require iron as a metabolic element to sustain life, iron-deficient individuals could not easily support bacterial growth and proliferation. Another possibility is that a serum protein factor, transferrin, which may play an accessory role in the natural ability of serum to stop bacterial growth, is elevated in iron-deficient states. Although these studies require further confirmation and exploration, the results so far again suggest that a kernel of goodness exists within the seed of evil.

Virtually all living species shelter and nourish parasites. Indeed, even parasites may have parasites. Some parasites cause disease; others are inertly benign. Still others, such as those mentioned here, may actually provide some benefit. Natural and experimental observations on the effects of parasites in lower animals lend further evidence for the latter relationship. The primary measure of beneficience applied in these experiments has been the increased size of weight of the parasitized host.

One of the earliest observations on this phenomenon was made by that remarkable naturalist-parasitologist Miriam Rothschild. She found that certain estuarine snails parasitized by the developmental stages of a trematode (the phylum of flatworms that includes the schistosome blood fluke of man) were much larger than parasite-free snails. She reasoned that the size of the host, which involves an increase in the soft tissue, as well as the shell, is of great advantage to the parasite. The faculty of producing this increase in size is a character that is most susceptible to selection.

Following Rothschild's lead, parasitologist Thomas Cheng and his colleagues at Lehigh University sought experimental confirmation for enhanced growth of trematode-parasitized snails. Their studies revealed that the infected snails were heavier than the uninfected controls but that this was due to a heavier shell rather than to growth of the soft parts. They attributed this effect to the parasite's destruction of the snail's digestive glands and the consequent release of calcium, which was then incorporated into the shell. Rothschild, however, believed that the parasite attacked the growth-regulating glands and in effect "caponized" the snails that she studied.

As we ascend onward and upwa
through the evolutionary tree, we fir
other intriguing examples of par
sites, provided they are not present
overwhelming numbers, stimulati
the growth of their hosts. Justi
Mueller's work on the implantati
of the larval stage of the tapewor
Spirometra ranarum into mice r
sulted in a weight gain that sometim
extended to obesity in his exper
mental animals. In this instance,
appears that, rather than altering th
hosts physiology, the parasite s
cretes a growth-stimulating, ho
monelike substance.

Perhaps the most ardent champio
of the harmonious parasite is Davi
Lincicome, formerly of Howard Un
versity. He and his colleagues co
ducted a series of exemplary exper
ments from which they showed th
rats and mice infected with *Trypan
soma lewisi, T. duttoni,* and the roun
worm *Trichinella spiralis* (the cause
trichinosis in man) all grew signif
cantly heavier than uninfected contr
rodents. What is even more amazing
that the trypanosome-infected anima
lived considerably longer than their u
infected cohorts. In one typical exper
ment, the control mice lived an averag
of 49 days, while the animals infecte
with *Trypanosoma duttoni* survived
average of 82 days. The apparent re
son for the longevity was that the par
sites provided the hosts with the esse
tial energy-mediating vitamins, thi
mine, pantothenate and pyridoxine.

Of course I do not counsel hype
tensives, asthmatics, and those who d
sire to prolong the salad days of the
youth to embark on a journey to t
nearest malarial, parasite-infeste
pesthole. I do believe, however, th
there is a lesson to be learned fro
a more tolerant view of host–parasi
relationships. Too often, biomedic
research takes a microcosmic, mole
ular approach, neglecting the clues s
generously provided by the events
the natural world. This, I suggest, ha
been an important reason for our ge
ting so relatively little bang for o
research buck. By expanding our i
sights into these dynamic relatio
ships and learning to control the e
fects without the infection, we ma
aid in relieving hypertensio
asthma, and the velocity of aging.

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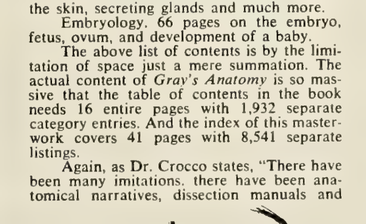

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Fig. 283—Surgical anatomy of the arteries of the neck, showing the carotid and subclavian arteries.

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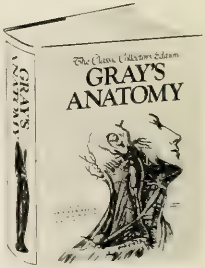

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The Call of the Duck

by Gilbert Gottlieb

Hearing their own vocalizations while still embryos apparently enables young ducklings to recognize the calls of their mothers after hatching

More than a hundred years ago, Douglas Spalding, a British scientist considered by many to have been the first experimental animal behaviorist, noted that “when guided by sight alone,” young domestic chickens “will follow any moving object,” but that when auditory cues are supplied, “their ear prior to experience attaches them to the *right* object [emphasis added].” Since Spalding’s time there has been considerable research showing that young birds of various species other than chickens—for example, wild and domestic ducklings—exhibit similar behavior.

Although Spalding did not know the social-ecological basis of his observations, it is now clear that this aspect of avian behavior is intimately correlated with the predominance of auditory over visual perception in the early social relations between the newborn and their mothers. (In most avian species, except songbirds, the male does not play an active role in incubation or otherwise take care of the young.)

In a previous article in this magazine (“Components of Recognition in Ducklings,” February 1965), I described my work on the early social interactions between mother and young in the hole-nesting wood duck and the ground-nesting mallard duck. The main, and entirely unanticipated, discovery was the start of a “dialogue” between the hen and her young that begins in both these species when the embryo “pips” the egg twenty-four or more hours before hatching. The hen of each species at that juncture utters a species-typical maternal call in response to the vocalizations of her young.

These embryos begin their social relationships with their mothers even before they can see them. Wood ducks nest in deep, dark cavities and the young do not have an opportunity to see the maternal parent until they leave the nest. She calls the ducklings out of the nest with essentially the same vocalization she emitted to the embryos and throughout the immediate posthatch brooding period of some twenty to thirty-six hours. The same situation pertains with the ground-nesting mallard, except that the young of this species can see the mother when she calls them from the nest. In both species, the maternal call appears to be almost irresistible. In wood ducks, once the call is initiated, the entire brood usually leaves the nest within two to four minutes, never to return. Mallard hens, on the other hand, sometimes have to make several efforts to get their entire brood to follow them out of the nest as group.

I took tape recordings of the species-specific maternal calls of mallar and wood ducks back to the laboratory to do some experiments. I wa about to have to relinquish a previously unquestioned assumptio concerning the perceptual basis of th early attachment between the hen an her young. Unaware, at the time, c Spalding’s observations on chickens I was completely convinced by th central theme of the imprinting concept, the crux of which was summarized in 1937 by Konrad Lorenz

> It is a fact most surprising to the layma as well as to the zoologist that most birc do not recognize their own species “instinctively,” but that . . . their reaction . . . [to] a fellow-member of the specie must be conditioned . . . during the ind vidual life of every bird.

The first experiment I did involve hatching wood ducklings and mallar ducklings in laboratory incubators i order to test the response of thes “naïve” young animals to a choic between the maternal calls of the tw species. Since the ducklings ha never been exposed to the materna call of their own species, I was certai that they would respond indiscriminately to the maternal calls c both species and not show a selectiv preference for that of their own species. I was wrong. The “maternall

(Please turn to page 44

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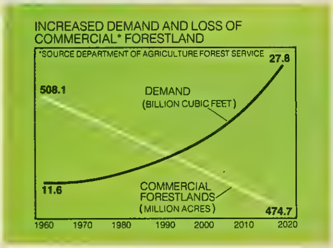

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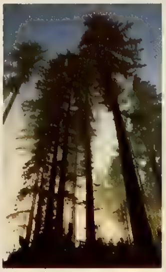
West

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forestry has found ways to make Mo
Nature more productive.

Great Lakes

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begins with the harvest. Slower grov
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at peak gro
And e

Actual tree diameter 9 3/16"

The two Douglas firs to the right grew in the forests of the Cascade Mountains of Washington State. Both were harvested when they were 25 years old. The difference is, the larger one grew in an Operation Double Tree area, while the smaller one did not.

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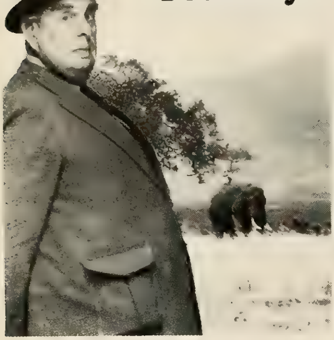

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naïve” ducklings were attracted to the maternal call of their own species even though they had never heard it before.

In retrospect, that response made good sense, but at the time it was a surprise. The explanation is that the attractiveness of the maternal call enables the parent to maintain control over the behavior of her highly active young at a time when the ducklings are particularly susceptible to such hazards as cold and predation. The hen can call her ducklings out of the nest and gather them to her promptly any time danger threatens. In the wild, ducklings are apt to become visually separated from their mothers in swamps and marshes. When that happens, the young can use the parent's call to locate her. The adaptive significance of the “built in” responsiveness to the maternal call is thus clear.

In terms of the development of species identification, the allure of the hen's call narrows the range of visual objects the young might otherwise approach, given their relatively nonspecific visual preferences. To determine that the call was a more powerful lure than the hen's visual attributes, I created an experimental situation in which the duckling could be near either the hen's call, issuing from a speaker concealed on a moving turntable, or her visual replica—in this instance a stuffed hen—but not near both simultaneously. All the ducklings, without exception or ambivalence, chose to remain near the source of the sound even though they had to track the moving call without helpful visual cues. In another test situation, I measured the ducklings' response to the call and to the visual replica of the hen when each was presented alone. Again, the response to the call was far superior. (The best response is achieved when the call is broadcast from a moving *visual* object. Interestingly enough, the moving object need not have the specific visual features of the hen, nor is the ducklings' responsiveness best if the object does have the visual features of a hen of their own species.)

Current experimental evidence accords almost perfectly with the observations Spalding made so long ago. The qualifying “almost” is necessitated by the most interesting part of my experimental results, which involved an investigation of the possible embryonic auditory factors that could have “tuned” the duckling to the hen's species-specific maternal call in advance of hearing it. This so of experimental attack on the bastio of instinct had been recommended b several scientists before me, but n one had previously singled out the appropriate instinctive behavioral phenomenon to trace back to embryoni existence.

What I was trying to ascertain wa whether the vocalizations of the embryo have acoustic features in common with the maternal call, so tha in hearing its own vocalizations th embryo becomes tuned to those of it mother. In other words, is the instinctive behavior of the newborn duckling dependent in part on prior auditory experience as an embryo? (should point out that this is not th same thing as asking whether human fetus exposed to the music of say, Chopin will develop into a adult devotee of the composer.)

In collaboration with John G. Vandenbergh, a colleague at the Nort Carolina Department of Menta Health, I devised a technique for muting embryos and eventually was abl to use this procedure to obtain an experimental result that clearly indicated that the ducklings' response t the maternal call of its species is dependent upon the young hearing thei own embryonic vocalizations. Th technique, which prevented the embryos from vocalizing, involved coating the syringeal membranes with a nontoxic surgical glue that prevente them from vibrating. The embryo were thus temporarily rendered mute (The effect wears off after one to tw weeks, leaving no permanent damage.)

Next the muted embryos were tested after hatching for a choice between the maternal call of their own species (mallard), the maternal calls of other duck species, and the calls of chicken hens. The muted ducklings chose their own species' maternal call over that of the other ducks forty-eight hours after hatching. But in discriminating between their species' maternal call and the chicken maternal call, the ducklings chose the chicken maternal call almost as often as they did the mallard call. (The reason for this unlikely result is that some critical acoustic features of the mallard maternal call are also present in the chicken call, but not in other duck maternal calls.) When some duck embryos were permitted to hear their own vocalizations for eighteen to twenty-four hours before being muted, they chose the mallard call

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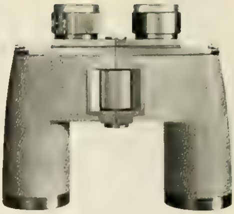

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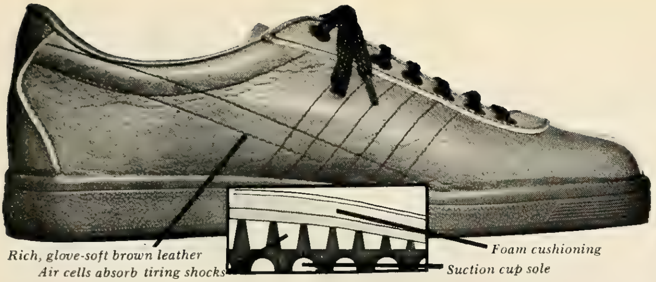
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over the chicken call when tested forty-eight hours after hatching, indicating the importance of embryonic auditory experience.

Duck embryos begin to vocalize when they move into the air space at the large end of the egg two to three days before hatching. They are capable of at least two distinctive vocalizations at that time: a harsh, loud, high-pitched alarm-distress peep and a soft, lower-pitched contact-contentment cheep. To the human ear, neither of these calls sounds anything like the maternal call. Nevertheless, while I could not perceive acoustic similarities between the embryonic and maternal calls, the ducklings might. By using analyzing devices I was able to determine that acoustic similarities do exist. Embryonic calls share at least three features in common with the hen's maternal call.

First, the range of frequencies of the low-pitched contact-contentment call of the mallard duck embryo and hatchling overlaps the higher frequencies of the mallard maternal call. Second, the characteristic repetition rate, that is, the number of notes per second in bursts of calling, is about the same in the embryonic and maternal calls. And third, the characteristic pattern of the way the frequencies change, or modulate, in time in the maternal call is also evident in certain of the embryonic calls, although the modulation in the embryonic vocalizations is very exaggerated and at a much higher pitch than in the maternal call.

The fact that muted duck hatchlings in experimental situations choose the mallard maternal call over the chicken maternal call when they have heard their own embryonic vocalizations, and fail to do so when they haven't heard these vocalizations, indicates that the embryonic vocalizations may be supplying some critical information about one or more features of the maternal call. And the fact that embryonic vocalizations and maternal calls share some acoustic features further strengthens the proposition that hearing their own vocalizations "tunes" the embryo to at least certain features of the maternal call of its species, thereby attaching it to what Douglas Spalding called the "right object."

Gilbert Gottlieb is a developmental biopsychologist in the Research Division of the North Carolina Department of Mental Health.

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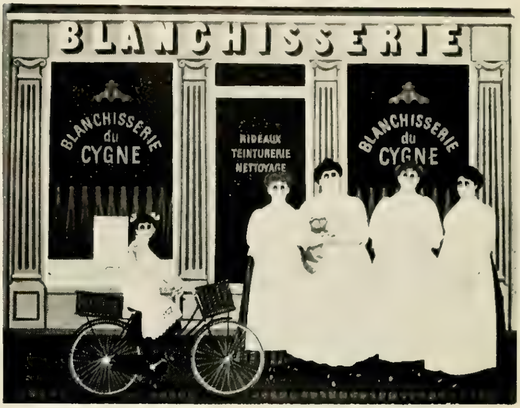

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Looms of Otavalo

by Joseph B. Casagrande
photographs by Victor Engelbert

The conquistadors may have destroyed traditional Indian society in Ecuador, but their presence resulted in an economic organization that survives to this day

Even on an ordinary day, there is a constant flow of people along the highway near Otavalo in the Andean highlands of northern Ecuador. Despite the burdens most of them carry on their backs—a sheaf of cornstalks, a roll of woven mats, a bundle of firewood—they usually walk at a rapid gait, as if on the verge of breaking into a trot, even while shepherding a flock of panicky sheep or prodding a few refractory pigs.

Their distinctive dress marks them at once as being both Indian and as coming from this region of the country. Although there are minor differences from one community to another, discernible only to the practiced eye, the basic costume is much the same. Even the clothing of the very young replicates that of the adults. For men, this consists of white, calf-length trousers fastened at the side, a white shirt, and a wool poncho, usually indigo blue in color, but more recently of a large-checked blue or tan pattern. Most distinctive of all is the long, single braid of hair, a symbol of ethnic identity and manhood.

Women typically wear two skirts of heavy blue or black wool, secured by one or more finely woven colored belts. Their lace-trimmed cotton blouses are elaborately embroidered with brightly colored floral designs. A large blue shawl, loosely tied in front, usually covers their shoulders. They may also wear a second shawl that doubles as a sling in which to carry an infant or other load. Perhaps the most outstanding feature of women's dress is their jewelry—multiple bracelets of real or simulated coral and strand upon strand of hollow glass beads wound around their necks.

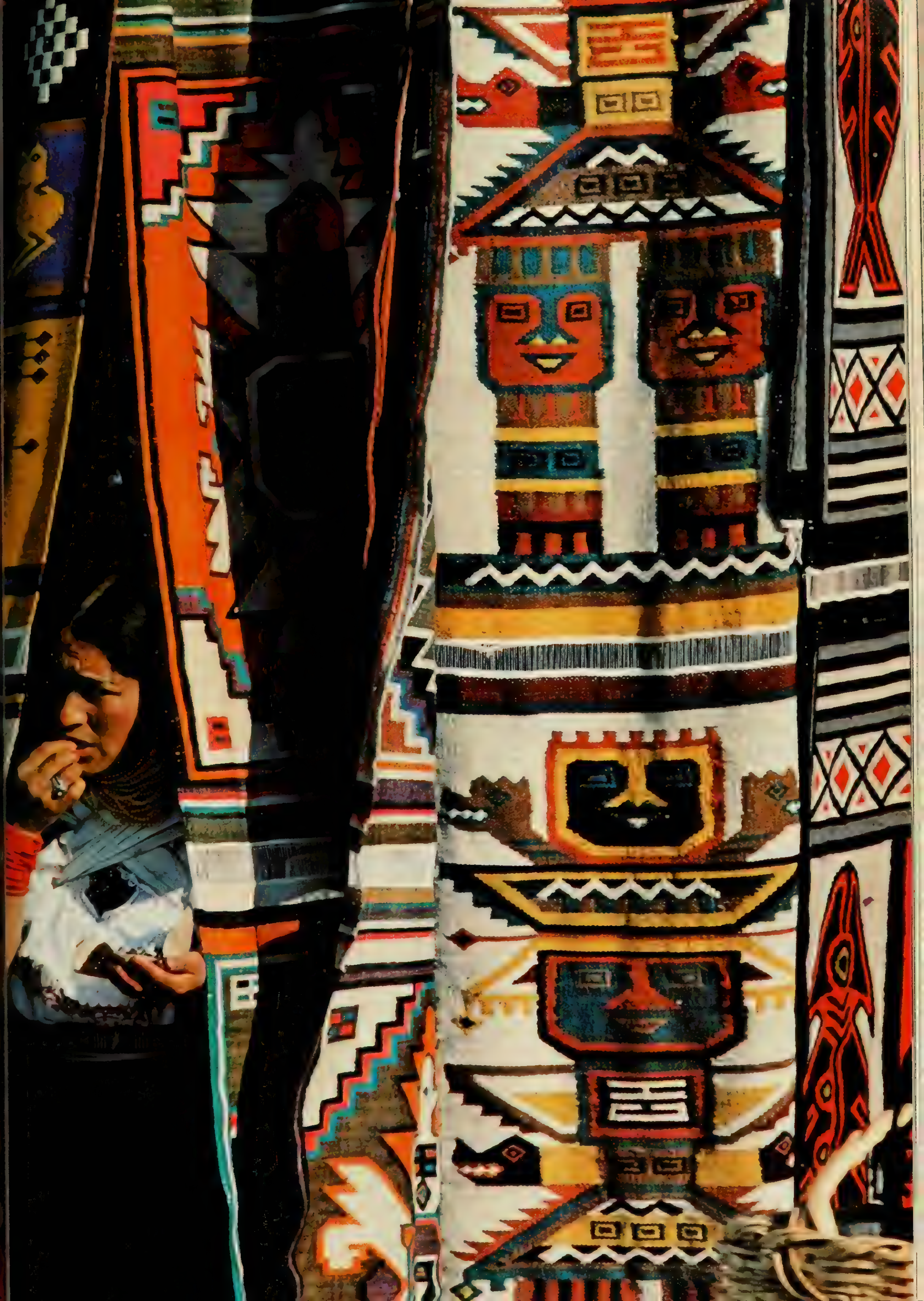
For centuries, the Indians of Otavalo have been weavers. Now, with the introduction of large-scale commercial weaving, many have achieved a degree of affluence unknown to other Ecuadorean Indians, most of whom are impoverished subsistence farmers. The products of the looms of Otavalo are sold in department stores and specialty shops throughout the United States and Europe, as well as by itinerant salesmen in virtually every large city in South America and the Caribbean Islands.

Of the forty to fifty thousand Indians living in the communities surrounding Otavalo, only one-tenth work as full-time weavers. Peguche and Quinchuquí, two villages a short walk from Otavalo, are foremost in the industry. Many Otavaleños (those who live in the Otavalo Valley) are also part-time artisans who make rush mats, pottery, and bricks. A few are still bound to haciendas as day laborers, but are no longer required to work four days a week in exchange for a meager wage, access to a small plot of land, and other hacienda resources.

Given the valley's high population density, land is prized and costly. Many young Otavaleños with no hope of inheritance are obliged to seek er ployment in occupations other then a riculture. There is, accordingly, steady stream of recruits into the wea ing industry. Many others, howeve must seek work elsewhere. The rece construction boom in Quito, spurred petroleum discoveries, has been prime source of employment. Othe work in Quito's textile factories. Son young women have entered domest service or work as salespeople or wai resses in Indian-owned shops in Quit

Weaving was transformed from handicraft to an organized indust immediately after the arrival of th Spaniards in the sixteenth centur After the conquistadors had secure what is now Ecuador for the Spanis crown, they lost little time in setting u institutions to exploit Indian labor an to drain off a steady stream of tribu into both crown coffers and priva pockets. The *obraje*—a kind of worl shop or primitive factory in which te tiles were produced—was among thes institutions. Established throughou Ecuador, the largest were operated crown enterprises, others were license

Peasants who do not ow enough sheep to provid sufficient wool for weaving mu buy additional wool in th market. Synthetic fibers are no becoming more commor



worked endless hours in cold, dark structures that were virtual jails. One official report in 1666 on conditions in an *obraje* near Pelileo in central Ecuador describes in gruesome detail how workers were flogged and died in chains for such offenses as falling asleep on the job, leaving the *obraje* without permission, or complaining about work conditions.

The community *obraje* of Otavalo was established in the mid-1500s by Rodrigo de Salazar, a conquistador

Most woven goods displayed in the Otavalo market are made for the tourist trade. Otavaleños usually wear traditional ponchos: blue on one side; a plaid design on the other. Patterns on long rectangles of woven cloth, which can be used for curtains or wall hangings, are not indigenous to Otavalo, frequently being copies of designs from isolated Ecuadorean towns.

o had received an *encomienda* from crown — a form of payment for vices rendered during the conquest. *encomienda* gave the holder the hts to tribute and labor exacted from pecified number of Indians residing thin a particular domain. At the ight of its productivity, five hundred lians labored in this *obraje*, including ys as young as nine years old.

Three hundred Indians worked in the guche *obraje*, begun in 1613 under ense by the crown. For the next two nturies this *obraje* suffered a series of cissitudes, but according to W. B. evenson, a British soldier of fortune, was still flourishing when he passed rough the area in the 1820s. He noted at the Indians seemed more inclined ward weaving than agriculture.

In 1863, Friederich Hassaurek, the st United States minister to Ecuador, ovided another account. "Peguchi is name of the factory and beautiful untry residence of Don Manuel Jijon . coarse woolen goods are made, ch as *bayetas* for ponchos, *jergas* for Indians, and shawls for their women ese shawls are dyed red, yellow, ue, or brown, but the red color is most demand); cloth for coats, vests, pan- loons, carpets, etc. These goods are ported chiefly to New Granada as far Pasto and Popayan in the interior, d Barbacoas on the coast."

During the nineteenth century, weav- g in Otavalo underwent a decline, due part to imports of inexpensive cloth om Great Britain. In 1917, however, a rtuitous event occurred that ulti- ately led to a renaissance of weaving d set it off in its present direction. ccording to one account, a wealthy sident of Quito was given a handsome d beautifully woven poncho. Greatly npressed with its quality, he sought out s maker, Jose Cajas of Quinchuquí, ave him an upright Spanish loom, and rsuaded him to try to imitate Scottish veed. Although the result was not veed, Cajas found a ready market in Quito for his homespun woolen goods. Other weavers soon followed his lead.

During World War II weaving was given further substantial impetus when imports from Great Britain came to a virtual halt. As a result, the demand for local woolen goods jumped ahead. After the war's end, however, the resumption of British imports stimulated the search for other markets and new products. Greatly improved roads and other means of transportation eased the way for salesmen who traveled throughout Ecuador and into neighboring countries. Added to this was a rapidly increasing influx of foreign tourists passing through Ecuador, many of whom were hungry for locally made textiles. The present-day, wide-flung weaving industry was on its way.

Today, the popularity and profitability of weaving in Otavalo continues to flower. It is nicely ironic that the weavers have turned to their own advantage the skills learned and perpetuated in the hard schools of the *obrajes* — the instrument of their exploitation has become the key to the greater economic independence and affluence they enjoy today.

In nearby Peguche, weaving is a constant activity, and scores of former residents carry on the occupation elsewhere. Virtually all men and most boys over fourteen, as well as a great many girls and women, work full time in some aspect of the industry. The household is the basic unit of production, and even the largest enterprises have expanded from this common base. Very young children assist in such simple tasks as cleaning raw wool, and from the time their legs are long enough to reach the pedals, young boys take a turn at the loom. Although many tasks are shared by men and women, weaving is strictly the province of the men and finishing the textile is usually women's work.

Weaving in this community has undergone a series of profound changes in recent years. The efficient Spanish loom replaced the back-strap loom, which dated from preconquest days, and now, power looms are beginning to supersede Spanish ones. The woolens and cottons formerly used for men's and women's clothing has virtually disappeared. Cheaper, factory-made cloth is now preferred. Gone, too, are the heavy woolen ponchos formerly woven on the old back-strap loom with laborious care. Very few people, even among the older men, still know how to weave the magnificent ponchos with a different color on each side. The hand-held drop spindle yielded to the spinning wheel, and it, in turn, gave way to manufactured yarn. Similarly, synthetic fibers are being substituted for wool and cotton.

Just as the materials and the technology of weaving have changed, so, too, have the products. These are now made with an eye primarily to the tourist trade and the foreign market. Among the more popular items are women's large fringed shawls, ponchos, scarves, shoulder bags, small tapestries, and ponchos for children. Shawls and ponchos are brushed with large burs to give them a soft, downy appearance that, incidentally, serves to hide imperfections in the weaving. The women's ponchos follow the same basic design as those worn by Indian men, but no Indian woman would ever wear one. Bright hues and pastels that span the whole spectrum are used. The center of the poncho often has a varicolored geometric animal or other design. Otavaleños, however, disdain these brilliant colors and large designs and prefer dark blue, black, and brown in their own clothing.

In communities not yet engaged in large-scale commercial weaving, older techniques are still practiced. A visit to such communities is a step backward in time. Here, one can still follow the laborious production of a poncho, from the cleaning of the raw wool to sewing the two halves together as they come off a back-strap loom. Only after studying the intricate procedures used to prepare raw wool for weaving, can one appreciate the eagerness with which orlon and other manufactured yarns have been adopted by the weavers. Workers must first remove bits of foreign matter from the wool by hand. They then wash the wool, often using the juice of the cabuya plant, which yields a cleansing foam. After drying, the wool is cleaned again, fluffed by beating it with a long rod, and carded to align the fibers in preparation for spinning. As it comes from the carder, each fluff of wool is rolled prior to spinning. For fine work, two threads are spun together or the yarn is spun a second time.

At this point the yarn may be dyed. Today, commercial aniline dyes are used almost exclusively, although a few

hildren, left, are dressed in e mass-produced, often foreign- ade clothing ordinarily worn y Otavaleños. Traditional, cally made costumes are served for special occasions.

people still use the fruit of the black walnut tree to make a dye that ranges from black to light greenish brown.

Even after all this, the process is far from over. The warp threads must be put on a special frame before being transferred to the loom. This is a complicated and variable procedure, depending on the type of loom used and the article to be woven. The weaving process is relatively simple and can be performed by an apprentice, but setting up the loom usually requires the expertise of a skilled weaver.

There are many ways in which individuals participate in the weaving industry. Many families carry out the entire process, from preparation of the wool to selling the finished product, but others specialize in only one phase. At one end of the scale is the man who spends a few hours a week on a poncho that may take him several months to finish; at the other end, the entrepreneur who employs about sixty persons in two round-the-clock shifts. In these small industries young Indian men, some little more than boys, from Peguche and other neighboring communities operate the imported power looms, while girls sew and do other finishing work. A steady stream of shawls, scarves, ponchos, and a variety of "novelty" items, all in garish colors and bold designs, comes off the looms. These are stacked in great piles in storerooms, either to be sold in quantity to salesmen or shipped directly to customers.

Although the industry depends greatly on its weavers, it is largely the salesmen who carry the flag of Otavalo identity. They travel to virtually every major city in South America and the Caribbean and venture as far afield as the United States, Spain, and even Germany. A familiar sight in every Ecuadorean city and town of any consequence, they can be spotted wherever tourists congregate: in ports and airports, in front of hotels, in markets, parks, and main thoroughfares. They do a lively business selling textiles to passengers and crew members of ships calling at Guayaquil, Ecuador's largest port. Wherever one encounters a salesman in South America, he is invariably dressed in full native costume, complete with braided hair. In a tropical port he may be drenched with sweat and still not shed his poncho.

As in other Ecuadorean towns, life in Otavalo revolves around the weekly market. Although Otavalo's weaving business has expanded far beyond the community's bounds, its local market is still important for the weavers and sellers of textiles, including salesmen—the more so since in recent years the market itself has become a prime tourist attraction. Saturday is market day in Otavalo. Beginning well before dawn, Indians from throughout the valley and from even farther afield begin to converge on the plaza. They come by foot, in packed and dilapidated buses, in trucks, taxis, and even in private cars. By sunrise, the usually empty plaza is transformed into a thronged market in full swing. But several hours later, the plaza is again nearly bare, and except for a few stragglers packing up their goods, the market is over.

The weavers of particular kinds of goods occupy the same relative positions each Saturday. Lined along one wall, they offer ponchos or other items that lie at their feet. Some have only a single garment, probably finished that week, while others have a sizable pile to sell. Cotton and flannel yardgoods, blouses, belts, and blankets, as well as shawls, scarves, and other tourist items are all displayed.

The future of these weavers is in many ways problematical. It is doubtful whether the industry's rapid expansion since 1950 can be sustained. Given the increased competition from those recruited to weaving in recent years, profit margins have fallen. Long gone are the days when a handful of pioneering salesmen sold their wares on the streets of Bogota at handsome profits. Quick to recognize a good thing, mestizos have begun to encroach on what was the exclusive preserve of the Indian. Abroad, there is increasing competition from finer textiles produced elsewhere. And unhappily, at least in my eyes, the goods now mechanically produced for a mass market have become increasingly shoddy and gaudy—a fate that has befallen native handicrafts throughout the world. ☐

Community work projects warrant the wearing of traditional dress. For women, this consists of a white and a blue skirt, a white blouse, and a blue poncho. Kerchiefs cover their heads.

The Auroras

by Raymond G. Roble

These brilliant displays of multicolored light may exert subtle effects on our atmosphere and weather

The polar regions of our planet are known for their barren, wind-swept ice fields and the feeling of desolation that may assail a traveler to those parts. But when darkness falls, the same traveler is often compensated by a dazzling display that can fill the entire sky. This multihued light show, known as the aurora borealis, or northern lights, in the Northern Hemisphere and the aurora australis, or southern lights, in the Southern Hemisphere, is an awesome sight to those who witness its largest manifestations. In polar regions, the aurora is a nightly event. At lower latitudes, it is less frequent. In most of the United States, these light spectacles can only be seen during geomagnetic storms, when the aurora moves from its normal polar position toward the lower latitudes.

The brilliant light emissions of the aurora are a sign that enormous amounts of energy are being transferred to the earth's high atmosphere, about sixty miles above the planet's surface, from the space nearby. Where does this energy originate? How is it introduced into our atmosphere? Does the aurora — and the energy transfer that accompanies it — affect our atmosphere and perhaps influence our weather? These are some of the questions that scientists are attempting to answer.

To examine the physical mechanisms responsible for the aurora, a huge volume of space surrounding the earth must be probed, directly by satellites and remotely by aircraft and ground-based instruments. It is not possible at the present time to put forth a unified theory of the many processes associated with the aurora with which all scientists will agree. Yet we are beginning to get glimpses of some fascinating effects associated with the aurora.

The ultimate energy source of the aurora is the sun—not the sun's radiant energy, but rather the solar wind energy that flows radially outward from the sun's surface in all directions. (The source and properties of the solar wind were described in "The Turbulent Sun," a special supplement in the November 1976 issue of *Natural History*.) Unlike the wind we know, the solar wind is composed primarily of charged particles, electrons and protons, which form a gaseous medium called a plasma.

The solar wind is turbulent, with large variations in its speed and density as well as in its magnetic and electrical properties. Because of these latter properties, the solar wind does not impinge directly on the earth's atmosphere but, instead, interacts with the earth's magnetic field, which extends high above the atmosphere. During the interaction of the solar wind with the outermost portions of the earth's magnetic field, electric and magnetic forces are generated that deflect the charged particles of the solar wind and cause the wind to flow at large distances around the earth toward outer space. The earth's magnetic field in this way forms a huge, invisible protective shield, called the magnetosphere, around the globe. The solar wind, however, is strong enough to distort the configuration of the earth's magnetic field as it flows by. The size of the magnetosphere depends on the variable strength of the solar wind. On the sunward side of the earth, the solar wind compresses the magnetosphere, which extends about 40,000 miles from the terrestrial surface toward the sun; on the night side of the earth, the solar wind stretches the ma netosphere into a long tail extendi about 400,000 miles from the earth surface.

The shielding property of the ma netosphere is not perfect. Small qua tities of solar wind particles and energ regularly enter the magnetosphere; b how much, varies in time. The amou appears to depend on such properties the solar wind as its speed, density, a magnetic field direction. Once insi the magnetosphere, the solar wi plasma is energized by electrical a magnetic processes and ultimately fin its way to the earth's polar atmospher where it produces the aurora.

The solar wind blows continuousl although variably, and the aurora consequently always present in t polar regions. In its typical form, t aurora is quiet and relatively smal suggesting a shimmering curtain or a of light. But observations show that n all of the solar wind energy entering t magnetosphere is steadily released in the earth's atmosphere in the form quiet auroral arcs. Instead, the ma netosphere has a tendency to store som of the solar wind energy for later di charge. When the energy stored in t magnetosphere develops an instabilit on a global scale, it is suddenly release from the magnetosphere into the a mosphere. These intermittent di charges, called auroral substorms, ge erally last a few hours before the auro returns to its normal condition of quie Substorms occur on an average of fiv to six times a day, every day, each tim

The facing photograph an
succeeding pictures of th
aurora were taken in Alask

Gustav La

epositing impulses of solar wind enrgy into the polar regions of our atiosphere at heights above about sixty iiles. The average rate of energy these uroral substorms release into the arth's atmosphere every day amounts o approximately a million-million atts.

Despite the regularity and energy of uroral substorms, they are not genrally seen at mid-latitudes. It requires geomagnetic storm, an event powered y still greater energy than a substorm, o make the aurora visible over the Jnited States, and even then the viewig is commonly restricted to the northrn part of the country. During geoiagnetic storms, the solar wind flowig past the earth is enhanced by the ruption of solar flares in the sun's atiosphere. Solar flares eject streams of nergetic particles from the sun into uter space. The particles that flow toard the earth require a few days of avel time before encountering the arth's magnetic field. In the course of ieir journey, the solar flare particles ombine with the solar wind, and when ie augmented solar wind interacts with ie earth's magnetosphere, a global eomagnetic storm occurs on earth.

Unlike auroral substorms, geomagetic storms are not a regular occurence nor do they follow any known imetable. They are characterized by ncreased auroral activity, which moves oward the equator from its normal poition. There are also changes in the arth's magnetic field strength caused y the intense electric currents of a few nillion amperes that flow into and out f the upper atmosphere during these vents. At these times, radio communiation may be disrupted and power failures may occur because of interference vith sensitive power monitoring ciruits.

A geomagnetic storm can last from ne to five days. During this period, the uroral substorm sequence continues as isual but the size and frequency of the laily substorms increase greatly. The mount of energy transferred from the nhanced solar wind into the magnetophere and then into the earth's atmophere in the form of the aurora can ncrease the energy level by ten times or nore that of geomagnetic quiet periods. As the strengthened portion of the solar vind flows by the earth and the solar vind returns to its prestorm condition, he geomagnetic storm subsides and auroral activity moves away from low and mid-latitudes, returning to its quiet-time position in the polar regions. The sequence of quiet auroral displays and less intense substorms also returns.

Satellite observations of the aurora show that it has considerable variability in its special extent, geographic location, and intensity, indicating that the solar wind energy input into the earth's atmosphere is also highly variable. Studies demonstrate that the energy from the solar wind can vary by a factor of 100 from geomagnetic quiet to geomagnetic storm conditions.

Bombarding streams of particles that have been accelerated from the magnetosphere into the upper atmosphere cause the atmospheric gases to glow and produce the auroral light displays. These particles flow along magnetic field lines from the earth's magnetosphere into its atmosphere in the vicinity of its magnetic poles. This is also the vicinity of the geographic poles. Particles flow through the rarefied regions in the magnetosphere without many collisions because there are few particles there with which to collide. As the particles flow toward the earth, however, they penetrate into ever denser regions of the earth's atmosphere and hence undergo more and more collisions with atmospheric gases. The particles can only penetrate the atmosphere to a depth at which the gases composing the atmosphere are dense enough to absorb the energy of the particles.

The energy of the auroral particles is such that when they collide with neutral atoms and molecules in the earth's atmosphere, they break the molecules apart to form atoms, excite the atoms and unbroken molecules to higher energy levels, and even ionize the atoms and molecules, that is, strip away electrons, leaving these formerly neutral entities in a charged state. In perturbing the background atmospheric gases in this way, the aurora changes the normal chemical reactions that occur in the upper atmosphere. About 50 percent of the energy of auroral particles goes into exciting atmospheric molecules and atoms to higher energy levels, causing them to radiate and thereby produce the dazzling light displays of the aurora. About 20 percent of the particle energy is involved in chemical reactions of atmospheric gases produced by the aurora, namely, atomic oxygen and atomic nitrogen; the remaining 30 percent of the particle energy heats the gases of the high upper atmosphere without exciting the molecules.

Low-energy particles (of a few hundred electron volts) deposit most of their energy high in the atmosphere at an altitude about 150 miles above the surface of the earth. Atomic oxygen is the main constituent in this rarefied region of our atmosphere. The low-energy auroral electrons excite atomic oxygen to a higher energy level, and when the oxygen atom releases its energy, it is radiated as red light. A completely red aurora indicates that the atmosphere is being bombarded with low-energy particles and that most of the particle energy is being deposited high in our atmosphere where atomic oxygen prevails.

Higher energy particles (of a few thousand electron volts) can penetrate deeper into the earth's atmosphere and consequently deposit most of their energy at a lower altitude of about sixty miles. These higher energy particles also excite the oxygen atom, but to a higher energy level, producing a glowing green aurora. When the oxygen atom is excited, it requires a finite time before it can produce light by radiating its excess energy.

The amount of time is determined by the level of excitation of the atom: 110 seconds for the atomic oxygen red line and about one second for the atomic oxygen green line. The red emission of atomic oxygen is suppressed at altitudes below about 125 miles because the excited atom loses its excess energy by collisions with other particles in the denser atmosphere of the region before it has time to radiate. But in the rarefied atmosphere above 125 miles, where collisions are infrequent, the red emission occurs. Thus, the visible color of the aurora is an indication of the height at which the bombarding particle energy is being deposited within our atmosphere: red near 150 miles; green near 60 miles. And the intensity of the aurora is related to the number of particles entering the atmosphere. The appearance of simultaneous red and green in the aurora indicates a mixture of low- and high-energy particles.

Particles with energies greater than a few thousand electron volts also bombard the earth's atmosphere. They penetrate to within fifty miles of the earth's surface but do not produce any visible light displays. Although the atoms and

Lamprecht

molecules of atmospheric gases are excited, they lose their energy very rapidly by collisions in the denser atmospheric regions before they can radiate. The visible light displays of the aurora therefore only occur above heights of about fifty to fifty-five miles. The energetic particles that penetrate below fifty miles, however, can cause enhanced ionization that affects radio waves and communications on earth.

The energy from the aurora, and its associated electrical processes, is as variable as the auroral light displays, but at times it can exceed the amount of solar radiant energy absorbed in the atmosphere above sixty miles. As a result, the earth's atmosphere above that height has a meteorology of its own, which differs somewhat from the familiar weather we experience near the earth's surface. Unlike the lower atmosphere, which is driven by direct visible solar radiant energy, the atmosphere above sixty miles is driven primarily by two other forms of solar energy: ultraviolet radiant energy and the energy of the solar wind that is deposited within our atmosphere through auroral processes.

For example, during spring and fall, the maximum solar radiant heating occurs at the equator where the sun is overhead. The incoming radiant energy heats the air in that region, causing it to expand and rise. As the heated air rises, it develops an increase in pressure and flows northward and southward toward the poles, which are cooler regions of less pressure. The mean wind circulation, or flow of air, in the upper atmosphere is consequently from the equator toward both poles. This circulation pattern exists when the aurora is quiet and ultraviolet energy is the main driving force in the circulation of the upper atmosphere. When the aurora is being turned on and off by daily substorms, however, the average auroral heating is large enough to disrupt the mean wind circulation. Occurring simultaneously in both polar regions, the aurora provides sufficient added heat to force the air to flow away from the poles toward the equator. Just how far back toward the equator the aurora-driven circulation pattern pushes the mean wind circulation depends on the size of the aurora. During very large geomagnetic storms, the auroral heating is so large that the airflow is completely reversed, and in most of the upper atmosphere above sixty miles, circulation moves from both poles toward the equator. Then as the aurora becomes quiet again, normal circulation in the upper atmosphere redevelops and the airflow moves again from the equatorial region toward both poles. Through these processes, the global atmospheric circulation above sixty miles is kept in a constant state of agitation, being forced one way when the aurora is quiet and in the opposite direction when geomagnetic storms are in progress.

The winds associated with the mean circulation pattern described above are quite strong compared with the winds we experience near the earth's surface. During quiet auroral conditions, the daily winds at heights of about 185 miles have typical velocities of 225 to 450 mph. When auroral activity increases, the winds also increase to speeds of about 670 to 900 mph. During very large auroral storms, winds approach velocities of 1,120 mph. During one large storm on July 4, 1974, a wind measurement of 1,433 mph at an altitude of about 150 miles was made from Fritz Peak, Colorado, about twenty miles west of Boulder.

The temperature of the upper atmosphere also increases by some 100° to 500°K during auroral events from its normal quiet time value of 1,000°K at heights of 150 miles. These large atmospheric responses take place in a region of our atmosphere that is very rarefied, where satellites in orbit experience only minimal air drag. Nevertheless, our upper atmosphere near the fringe of outer space can undergo large temperature and circulation changes whenever the aurora interferes.

The effect of the aurora on atmospheric motions and temperatures diminishes progressively below 60 miles. At that altitude the atmosphere becomes so dense, as compared with the rarefied region near 150 miles, that changes in atmospheric circulation and temperature caused by the aurora are relatively small and difficult to detect. Yet, some scientific studies have suggested that the aurora can affect weather even near the surface of the earth. Such a relationship between the aurora and surface weather is difficult to understand. Auroral energy, although large enough to cause changes in the atmosphere above 60 miles, is about a million times smaller than the visible radiant solar energy that drives the surface weather. What physical mechanism ca account for the influence of the auro on our weather?

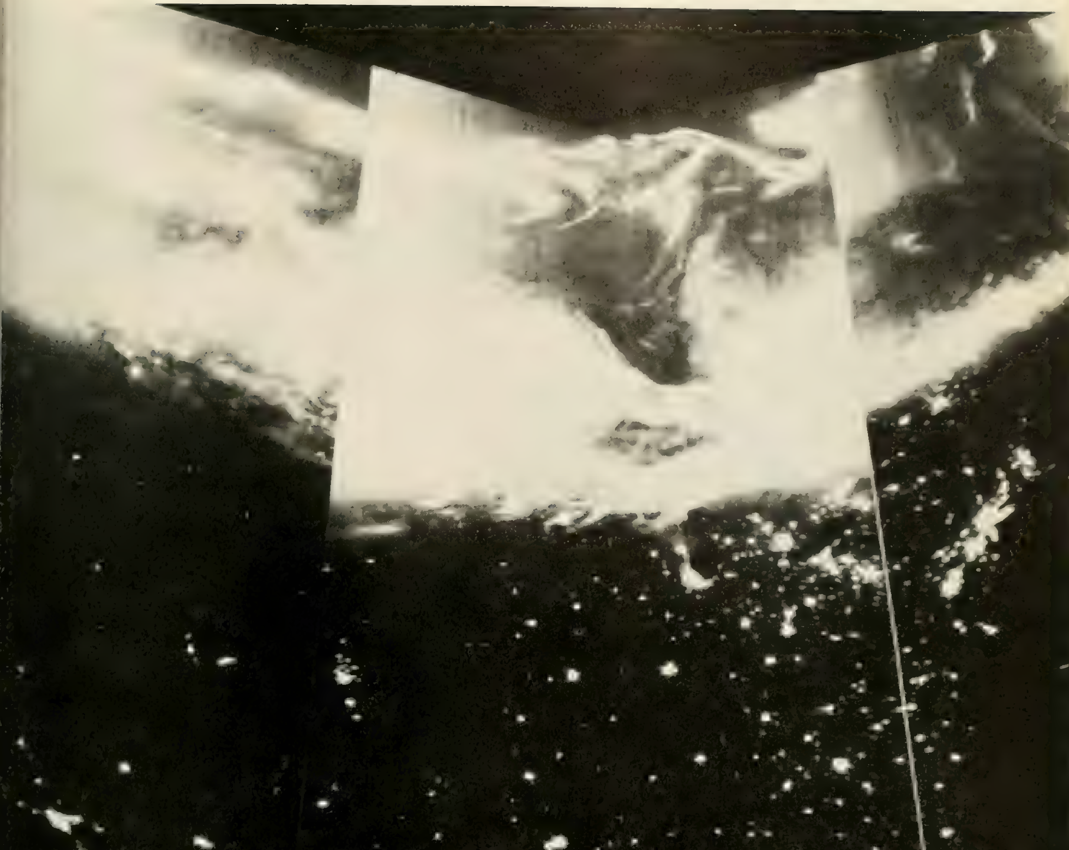
Auroral activity is related to su spots; both have a well-define eleven-year cycle. Auroral activity greatest when the sun has the large number of sunspots. The sun also has twenty-two-year cycle, composed two eleven-year cycles, during whic the sun's magnetic poles are reverse Studies of droughts on the high wester plains of the United States also reveal twenty-two-year cycle. The well known dust bowl of the 1930s, the dr period of the 1950s, and the curre drought in the western states have a occurred during periods of sunsp minimum and minimum auroral acti ity. Can this be mere coincidence or the aurora really affecting our weathe in some subtle way?

No matter what the answer to tha question may be, the aurora does produce a number of clearly documente effects on our atmosphere. The increased ionization that results fro bombardment by auroral particles affects the ionosphere (the outer part o the atmosphere, beginning at an altitude of about forty miles) and radi communication. Very energetic particles, penetrating deep into the atmosphere, produce chemical constituent that affect the ozone layer, fifteen t twenty-five miles above the earth's su face, which shields us from harmfu solar radiation.

We are beginning to understand th effect of auroral activity on the uppe atmosphere, but it is going to be ver difficult to find and verify auroral effects on the lower atmosphere, particularly those associated with weathe events. Until that is accomplished, th aurora will remain a demonstration o the terrestrial effects of the vast sola wind, producing the greatest light sho on earth. □

Charged particles from a sola flare on April 14, 1974 contributed to the larg auroral displays encirclin the northern border of th United States, as shown in thi composite satellite photograp taken several days later

World Data Center,



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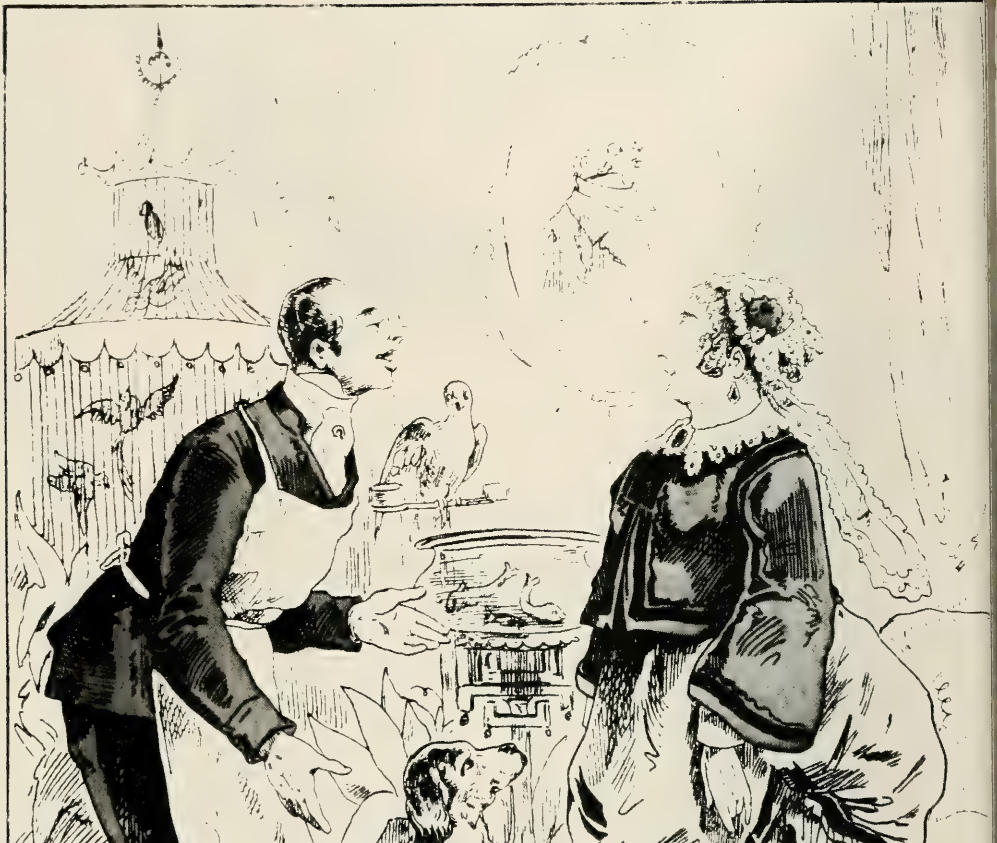


Surrounded as you are by animals, Madame, you need not fear starvation!

The Siege of Paris

y Gerald Carson

aced with starvation,
arisians consumed their
ets and zoo animals

Without allies or a ready army, apoleon III, the emperor of France uring the Second Empire, was maipulated into attacking Prussia, the rongest military power in Europe, n a point of etiquette. Thus, by delaring war on July 19, 1870, he reated an empire—the German—nd collapsed another—his own.

Following the catastrophic defeat f the French army and the capture of ouis Napoleon at Sedan, two Prusian armies, moving rapidly, reached round the City of Light like the laws of some giant crustacean. The trategic plan was simple—it would e cheaper to starve the city than to ssault it. The defenses were formiable: a garrison of 180,000 troops of he line, a body of marines, and reervists called Mobile Guards, plus 00,000 National Guardsmen—esentially untrained, part-time soldiers, ut full of fight. Ramparts, averaging hirty feet in height, surrounded by a itch eighteen feet in depth, and with glacis in front covered by felled rees, enclosed a circle of nearly wenty-one miles. Seventeen deached forts defended the approaches o the main fortifications.

An odd euphoria seized Paris, as vell as a fanatical determination to esist the Germans. Having vowed to ight to the end, the Parisians were onstrained to do it. A republic, the Third, was proclaimed. Amidst general rejoicing over being rid of the Bonapartist Second Empire, the foreign invader was for the moment trangely ignored. The imperial eagles were torn from public buildngs and military shakos. Street names celebrating the late regime were expunged. One shouted for *la patrie,* sang the Marseillaise, shook hands, and wore something red—a carnation, a sash, a cockade. The bust of Napoleon III at the Comédie Française disappeared from view, and an American dentist, Dr. Thomas W. Evans, gallantly spirited the Empress Eugénie off to England.

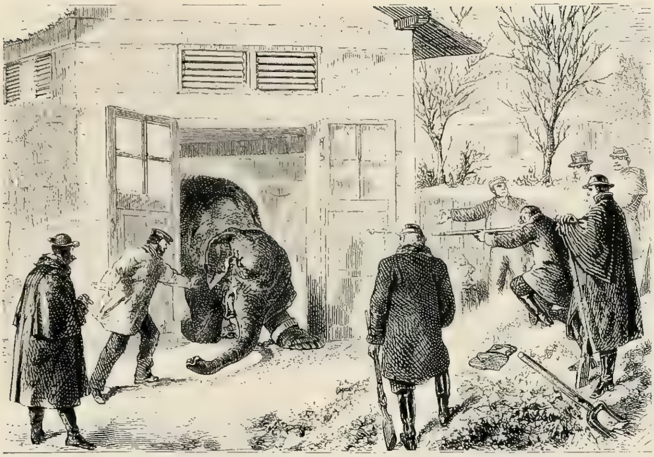
Uncomplimentary stereotypes about Napoleon's big nose and the empress's morals provided caricaturists, songwriters, political journalists, and the radical political clubs with inexhaustible material for piquant and often scurrilous commentary. Hawkers cried up their leaflets and satiric broadsides on the boulevards: "The Conspiracy of the Jesuits Against the Republic!" "The Confession of Napoleon III," "The Bonaparte Woman, her Lovers, her Orgies." One cartoon depicted Bismarck, the Prussian chancellor, as a cook and explained why the Germans neither bombarded nor attacked. The placard showed the Iron Chancellor as saying: "To cut down these Parisians whom I detest, it is necessary to let them stew in their own juice until the right moment."

Inside the city, the theaters, cafés, and boulevards were crowded and colorful. There were flowers, illuminations, and the sound of drums and bugles. Patriotic visits were made to the statue of Strasbourg in the Place de la Concorde to honor the fortress in Alsace that was putting up a heroic defense. Spy hysteria erupted. One American clergyman was arrested and dragged off to prison for writing in his diary what he had for breakfast. The suggestion was considered of arresting the functionaries of the late imperial bureaucracy, although the appropriate question was how to arrest the Prussians.

Everyone who could put on a uniform did so, including pretty ladies who competed aggressively for custody of the limited supply of wounded soldiers then available. A wounded man was valuable. He defended a residence against the billeting of refugee peasants, against incendiarism from social malcontents, against robbery or possible Prussian requisition. Semaphores signaled by day from the Arc de Triumph, and giant electric searchlights on the hilltop at Montmartre swept the northern approaches to the city at night. Soldiers drilled in the squares. War industries hummed in factories and railroad stations and the gardens of the Tuileries palace were chock-a-block with caissons and cannon. The opportune appearance of the aurora borealis early in September offered convincing evidence to those with a receptive cast of mind that nature was signaling an early deliverance for France, while the devout put their faith in Saint Geneviève, the city's patron saint. But the early enthusiasts who had purchased maps of Prussia in order to follow the triumphant French army on its march to Berlin quietly put their *cartes* aside. Mass graves were being dug at Montmartre.

There would be food enough for all, the Government of National Defense announced. Two hundred and fifty thousand sheep and forty thousand oxen herded into the Bois de Boulogne, bleating and bellowing unhappily, made a bucolic scene where but lately the world of fashion and elegance had taken its pleasure. Thousands of meat animals milled about in the confines of the Luxembourg Gardens, while masses of agitated cattle blocked the boulevards, pushing against the horse chestnut trees and the urinals. The huge central market was filled with casks of smoked or salted meat, barrels of flour, great wheels of cheese, mountains of dried vegetables. The partially completed Opéra, the marble-and-gold masterpiece of Jean Louis Charles Garnier, was converted into a water reservoir below, and transformed above into a bakery, a hospital, and a depot for food and army clothing. Fruits, fresh vegetables

Culver Pictures



Shooting an elephant for food at the Jardin d'Acclimation in Paris

from nearby truck gardens, dairy products—all the components of the traditional French cuisine—poured into the city although rising prices began to cause some apprehension as early as August.

September was never more warm and beautiful and early October provided a delightful interlude of Indian summer. While the weather held, and before the Germans had completed their encirclement, the general public was invited to clean out the game in the oak-and-chestnut forest of Compiègne, once the hunting preserve of kings, to deprive the invading army of meat and sport. In the suburbs, houses were leveled and trees cut down to create fields for artillery fire. The exodus of upper-class families to Brittany, Normandy, Tours, and Bordeaux was more than replaced by an inflow of refugees who temporarily provided more food than they consumed. According to a story widely circulated at the time, a farmer-refugee, who brought his way of life with him, was lodged in a handsome mansion and soon smelled up the neighborhood. The owner of the property investigated and found a rooster and his harem on the balcony. The antechamber was muddy and well manured. The next room was a rabbit run. The master bedroom contained a basin for the ducks, and gruntings from the drawing room announced the presence of a pig. When the owner of the residence asked why the farm animals could not have been kept in the garden, the farmer replied: "But it is the time for sowing and where would I sow my barley?"

The theaters were closed by edict of the Provisional Government, not for any good reason, but because that is the sort of thing governments think of. Meanwhile, those with ready money laid in private stocks of foodstuffs and gave chic siege dinners—*un dîner de siège* was the phrase in vogue—as a kind of defiance of the enemy and to break the ennui. Recreation was narrowly limited. One asked for the news, but there was no news. On Sundays, crowds rode on the beltway railroad inside the ramparts, climbed the walls to gaze at the French outer forts and the Prussian batteries through telescopes or opera glasses, or chatted with the Mobile Guards who had little to do except gamble, drink to the point of indiscipline, and hunt rats. By mid-September, Paris saw its last train depart, last regular mail delivery; and Felix Turnachon, an ardent believer in airships, was testing the possibilities of communication with the outside world by balloon flights.

The public powers were reassuring. Louis Trochu, president of the Government of National Defense and military governor of Paris, proved to be a talkative general who declared that if the Germans penetrated the fortifications, they would be killed and provide abundant humus for future generations of Frenchmen. Privatel Trochu was lukewarm in loyal toward the republic he headed a considered capitulation inevitable. military officer of towering incomp tance, the general's first probing so tie was a failure, as were all his subs quent efforts to break through t German lines. Trochu talked much his plan. But in fact he had no plan

Mid-October. Chill rains turning sleet fell heavily from gray skie Lack of heat and light posed ne problems; the food situation gre tight. The outlines of "the terrib year" were becoming visible. Th government had only the vaguest ide of how many people were in Paris– the actual number on December 3 1870, not counting armed forces, wa 2,005,709—nor did it develop rel able information as to the quantity food available. But those in authorit calculated roughly that all could b fed for eighty days. After that, Prov dence or Saint Geneviève woul surely intervene.

The foreign population was the ob ject of some hostility as representing like animal pets, unnecessary mouth to feed. United States citizens wer generally well regarded for a numbe of reasons: because this country wa the first nation to recognize the Thir Republic, because Americans wer not numerous, and because the Amer ican legation was headed by a re markably able diplomat, Elihu Benja min Washburne. Washburne was th only minister of a major power wh stayed in Paris throughout the siege The American "ambulance," mean ing hospital (drawing on the lesson of our Civil War), also had the bes record of all in the city for the car and recovery of the wounded.

Bread was price controlled and di not yet present a problem althoug the quality was dropping. Win flowed like water. There was plent of mustard but little beef to put it on As early as September 27 there wa an angry demonstration on the Boule vard des Italiens against the foo speculators and the inequities alread opening up between the rich and th poor. A curious phenomenon arose All Paris was seized by a sudden an uncontrollable appetite. Those for merly content with two eggs and a bi of cheese now wished for red meat grilled rare, and a bottle of Burgundy

Potatoes and dried beans rose four six times in price and shortly disap-ared from grocers' stocks. A laying n was truly a bird that laid golden ggs. "Lamb" was still displayed in e shops and appeared on restaurant enus but, curiously enough, at the me time the dog population ropped sharply. "Rabbit" became a mmon euphemism for cat or kitten, ften smothered in onions or served s a stew. Accomplished hosts, noted r their good tables, offered—ithout apology—*le rat, sauce adère.* The fork hesitated over such ishes. But cultural conditioning gainst unaccustomed viands could ot hold out indefinitely against the nperious demands of a growling tomach. One meat, the flesh of the illygoat, defeated the best efforts of e most ingenious cooks. As one res-urant proprietor noted despairingly, *l m'a été impossible de faire dis-araître l'odeur.*

Parisians disdained horse meat hen it first appeared on the market, or the French do not modify their ating habits lightly. Louis XVI, it vill be recalled, was obliged to wear he blossom of the potato plant as a outonniere to persuade his subjects to accept the white tuber as an element in their diet. At the commencement of the siege, the notion of eating horse produced a shrug and a grimace. But Dr. Edme Bourgoin, chief pharmacist at the Children's Hospital, lectured on the healthfulness and nutritive values of horseflesh. The government instituted inspection at the horse markets. The press and the Horse-eating Society praised horse beef. Hippophagous fare carried the day, winning acceptance first among such group leaders as scholars, writers, artists, and journalists. The fat of the horse was also pushed as a butter substitute since even lard had become mythical, something remembered nostalgically from a former life. People formed lines just to gaze when a luxury shop at the Palais Royal displayed a single pat of butter, like some precious jewel, centered for dramatic effect on a stand that slowly revolved.

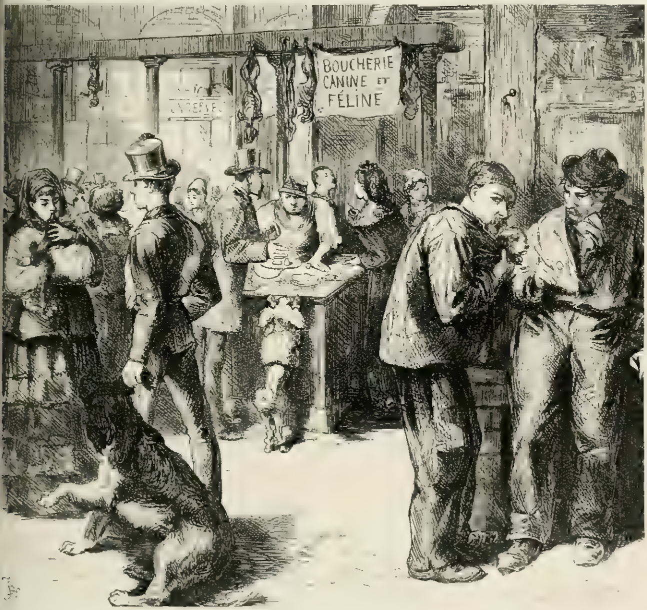
Butcher shops were frequently shuttered. When they were open, meat was obtained only after hours of waiting. The customer presented a roughly printed blue ration card with coupons attached. As the supply of horses diminished, the meat allowance fell from 150 grams (slightly more than 5 ounces) a day per person to 100 grams, then to 88, and finally to 33 per day (or slightly more than an ounce). Before long the queues of patient women obtained horse beef only after the animals had died on the battlefield. About 70,000 horses, it is estimated, were eaten during the siege.

Théophile Gautier, the novelist and critic, who published a volume of eyewitness vignettes of life during the siege, speculated on whether animals respond to events around them that are outside their instinctive sphere. He concluded that they might not know what King William I of Prussia, General Moltke, and Bismarck were up to, but they sensed well enough that all was not as it should be in Paris. Dogs reproached their masters who offered meager rations, often of gray, gluey bread, asking with pleading eyes for what fault they were being punished. Lost dogs from the provinces, trying to find a new protector, rested their muzzles in the palms of passersby, pledging good and faithful service if only they would be received. And then they noticed that people were looking at them in a peculiar way; that the caressing hand was feeling them over with the fingers of a butcher. They had become game and were in mortal danger of the running knot, the sack, and the club. Cats assessed the situation first. Prudently, they took to the rooftops and deep cellars to avoid ending up on a sharp hook invitingly set off with paper frills and colored ribbons.

To many, the idea of eating dogs was revolting. One French journalist wrote that he could only compare it to Orestes, of classical literature, eating his best friend, Pylades; or to Paul devouring his true love, Virginie. But as with the horse dilemma, hunger has a marvelous effect upon attitudes. In the last bleak months of 1870, specialized canine and feline butcher shops opened in many locations. They also handled rats.

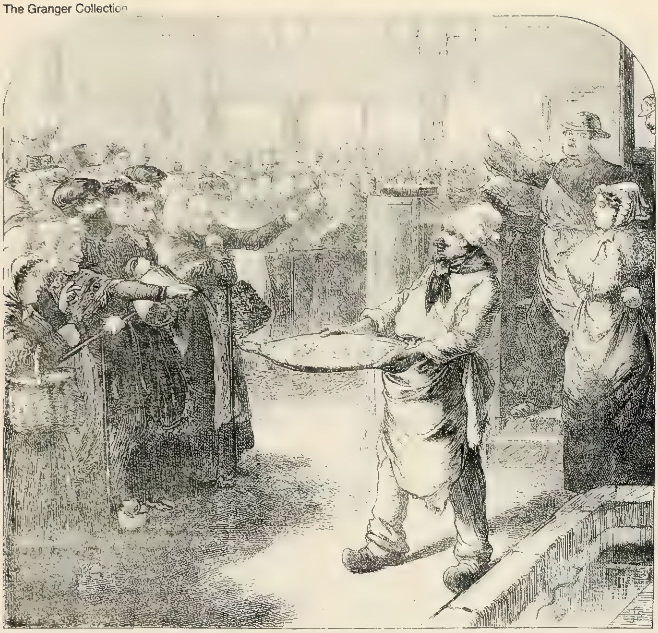
During this time of misery and near starvation, French wit still flashed across the pages of the illustrated papers. One cartoon set forth the risk involved in eating rats by picturing a cat that had jumped down a man's throat after the rat, leaving only its hind legs and tail sticking out of his

ie Granger Collection



Parisians selling pets at a market specializing in dog and cat meat.

The Granger Collection



A fish market holds a public auction of its dwindling supplies.

mouth. *Le Figaro* printed the story that a pack of dogs pursued a man who could not understand their interest in him until he remembered that he had eaten a rat for breakfast. Another illustrated sheet showed a handsome officer escorting a young lady into a restaurant, a loaf of bread under his arm. A sign on the wall warned, "Clients Bring Their Own Bread."

Gallows humor often turned on the fate of pets. A good bourgeois couple had a little dog of whom they were very fond. But a day came when there was nothing to eat. Their companion had to be killed and cooked. His master and mistress ate with tears in their eyes, and as the wife mechanically placed tiny rib bones on the side of her plate, she sighed, "What a treat these would have been for poor Bijou!"

Nerves grew taut while the besieged city waited for the attack that did not come. Sorties were made but bloodily repelled, while crackpot ideas proliferated for dealing with the impasse. One idea was to infect dogs with rabies and turn them loose on the Germans. Another suggestion, endorsed by a number of journals, was to release the carnivorous animals in the zoo against the besiegers. A difficulty, of course, was that the beasts would have to be familiar with the Prussian uniforms so as to know whom to attack. Since balloons could not be steered, another Rube Goldberg idea for achieving improved communications with the rest of France was to have the balloons pulled by four eagles while the human passengers in the gondola pointed poles skewered with red meat in the direction desired. The use of pigeons to carry messages worked reasonably well until the winter storms arrived. The carrier pigeon came to be regarded almost as a sacred bird, reasonably safe from ending up in a pigeon pie. Paris was especially bitter when the Germans imported falcons from Saxony to bring down the winged messengers, which bore such affectionate names as Gladiator, Vermouth, and Fille de l'Air.

November and December were bone cold, gloomy, snowy. The Seine froze over. Alternate street lamps were cut off. Transportation was almost nonexistent since most of the omnibus company's horses had been sacrificed. For a time in November the theaters reopened, giving short benefit performances—a mov ment from a symphony, scenes fro Corneille's *Horace* or Molière's *T Misanthrope*—for the wounded, tl orphaned, or for the purchase of cannon. Ernest Lebouvé, the pla wright, lectured on "Moral Fo During the Siege," and there we poetry readings from Victor Hug Mlle. Marie-Justine Favart, lookir adorable in a satin dress that su gested the plumage of a dove, deli ered a charming topical poem calle "Les Pigeons de la République," an at matinees on the Left Bank, Sara Bernhardt of the Odéon passed th hat. It was, appropriately, a Prussia helmet.

The performances ceased by th end of December because of the col and lack of fuel and light. Many restaurants closed. Even such a well known rendezvous as Chez Brébar 32, Boulevard Poissonière, wher Edmond de Goncourt joined friend in the arts and sciences to dine an talk, shut off the gas at seven-thirty The amenities of life steadily shrank While lunching at the Tavern d Lucas, Goncourt found on his bil a charge for the napkin, reflecting th difficulty of obtaining hot water an fats for making soap. Men walke home through silent streets, hearin perhaps the clop-clop of a singl fiacre, while finding their way with lantern as in the middle ages. The silence, *L'Illustration* said, was oppressive enough to make one think h was in Carpentras (chief town of th Vaucluse)—a French way of sayin that Paris had become Dullsville. Th American minister, who had been congressman from Illinois, said tha the Champs Elysées in January mad him think of Main Street in Galena Illinois. Hunger, cold, dirt, and malnutrition were doing their work. Public health took a sharp downturn du to respiratory diseases, diarrhea, dysentery, cholera, and smallpox, which together tripled the mortality rate.

Parisians of whatever class were startled when they happened to pass the show window of Chevet's of the Palais Royal. Chevet's had been a famous luxury food emporium, somewhat like Fauchon's today on the Place de la Madeleine. Chevet's had been known for artistic compositions of fresh fish on marble tables, lobsters and turtles surrounded by

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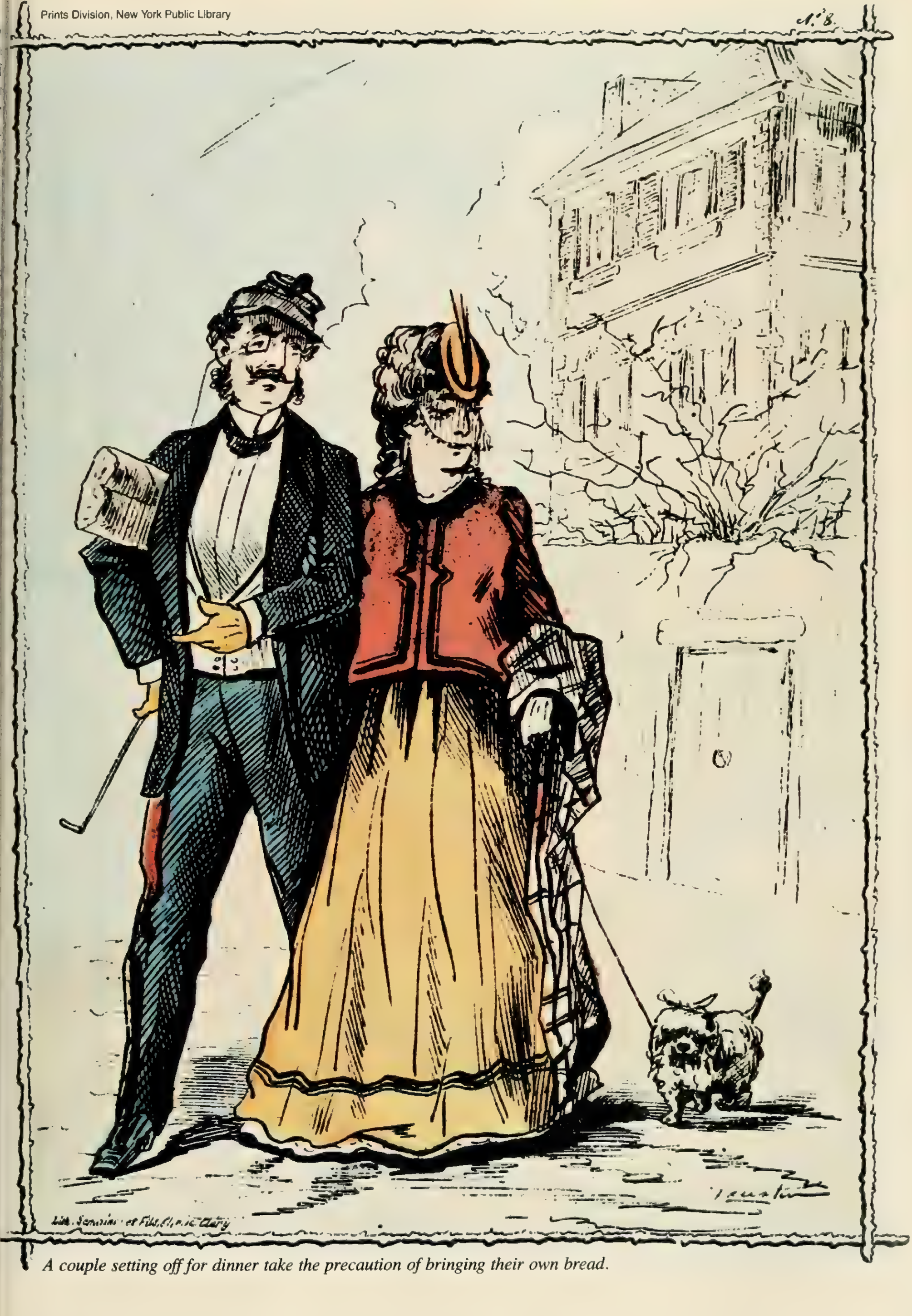
N° 8.
Lith. Sennine et Fils, Cl, r. de Clery

A couple setting off for dinner take the precaution of bringing their own bread.

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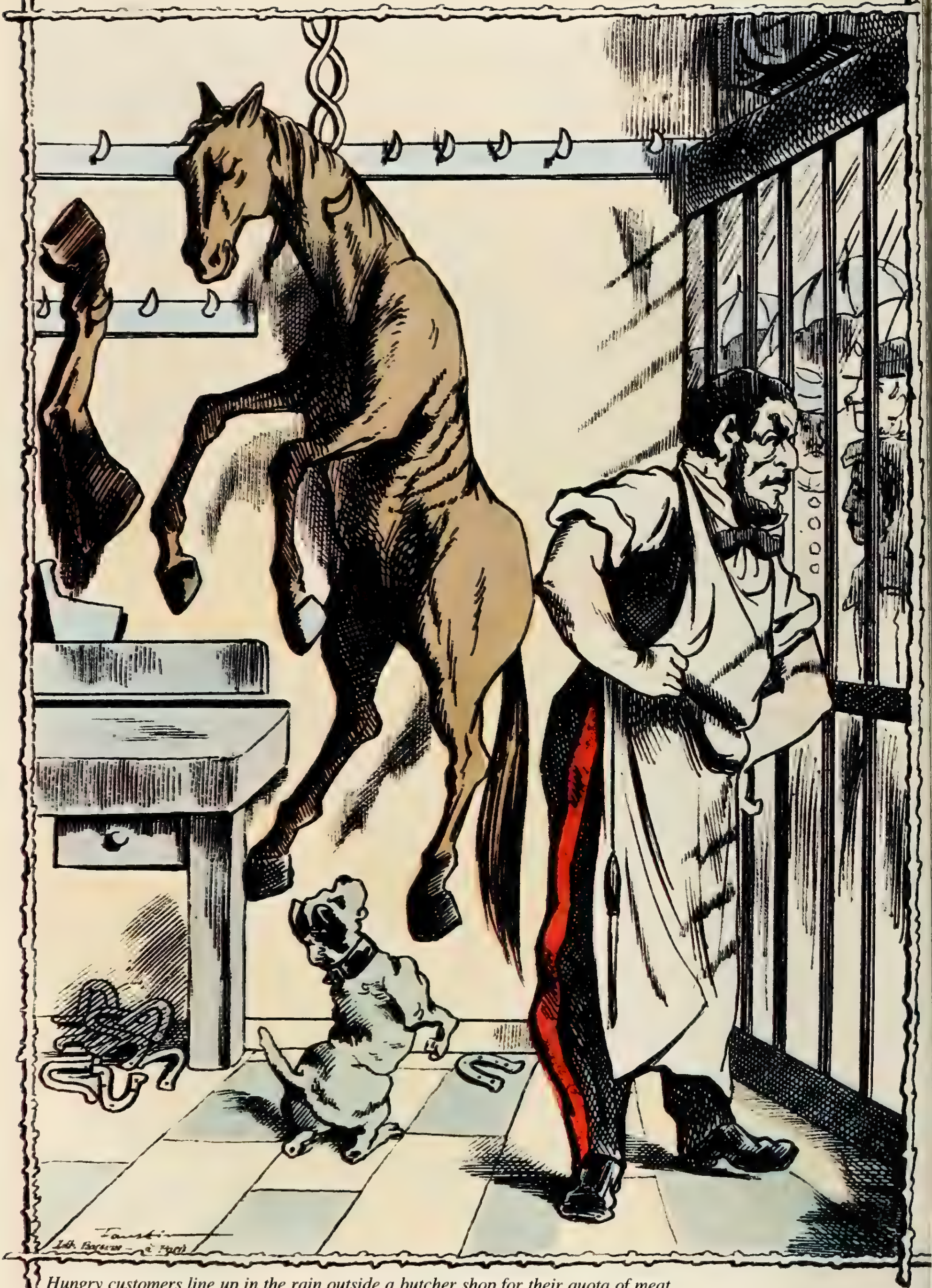

Hungry customers line up in the rain outside a butcher shop for their quota of meat.

oss, fat turkeys, deer hanging in ont of the boutique. Other featured licacies were the fine chickens of ans, pheasants, Scotch grouse, not omit the paté de foie gras, broettes of ortolans, peaches and megranates, pears worthy—it is autier speaking, almost overcome his memories—of the grand dukes Tuscany. But gone, all gone, were e gratifications of yesteryear. Inead, the stroller saw the blinding art the tinsmith—in other words, nned goods. The containers were und, square, oblong, but all were iny and all were ticketed with proibitive prices. Only those who still ad gold or bank notes could touch em. For the poor, the government stablished municipal butcher shops nd canteens. For bread, they ate a ray-to-black lump compounded of ats, bran, rice, barley, straw, and ther ingredients not readily identiable. By mid-January the governent did what it had vowed it would ever do—forbade the free sale of read altogether, allowing a daily uota of 300 grams for adults; for hildren, half that amount.

Osséine, an ersatz food devised by e chemist Edmond Fremy and conaining ground-up bones, was introuced; also a kind of artificial milk. 'You talk about what is eaten, can e eaten, or can be found to eat,'' oncourt confided to his diary. 'Conversation does not go beyond hat.'' Each problem tied in with ome related shortage. With coal, oke, and wood disappearing, mobs lesperate for heat snatched away ences and benches, raided the wood ard in the rue Biot. They broke up loors, furniture, and leveled the renaining trees in the parks and along he great avenues, the Champs lysées and nobly shaded, fashionble streets in the west end of Paris, uch as rue Montaigne or the handome Avenue de l'Imperatrice (now venue Foch), where the American ninister lived. Here Washburne saw vomen and children hacking away at he trees, gleaning every branch and wig, anything for fuel to cook their rams of food and create some varmth on the home hearth. The reen wood, unfortunately, produced nuch smoke and discomfort, but litle flame or heat.

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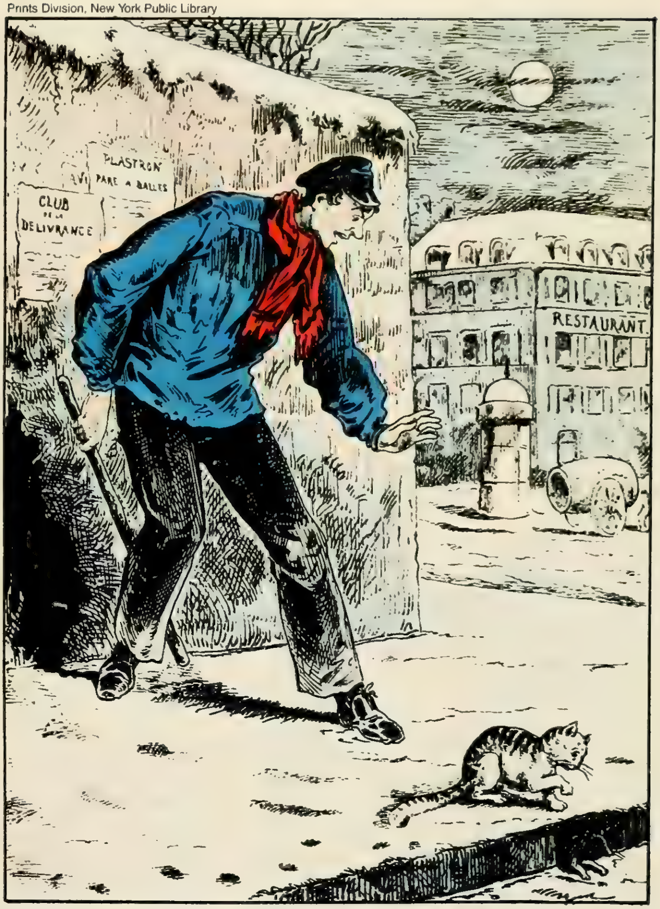

With food stores empty, the predator becomes the prey.

The menagerie animals represented a last food resource. It was a telling point, too, that it grew more and more difficult to support them. An enterprising butcher began the zoo slaughter and resold his carcasses at astronomical prices. The establishment carried on its business under the name of Boucherie Anglaise, possibly to deflect the sorrow and anger of zoophiles by placing the onus for what was happening on the English. England was already exceedingly unpopular because its government had made no serious effort to help France extricate herself from the grip of the Prussians. At any rate, dog's leg flanked with rats, *sauce poivrade*, was varied at the Boucherie Anglaise (for those who could pay the tariff) by the flesh of unusual creatures—bear, antelope, kangaroo, ostrich, yak. Antelope, for instance, cost 18 francs per pound—call it $16 a pound in 1977 dollars. Two young elephants named Castor and Pollux, the pride and joy of Paris, were ineptly executed by explosive bullets and retailed at 20 francs per pound; however, the trunks, being especially choice, brought from 30 to 45 francs. Voisin's restaurant offered elephant blood sausages the evening of New Year's Day. A few days earlier a supper was tendered in compliment to M. Bonvalet, mayor of the Third Arrondissement, at the well-known Peter's restaurant in the Passage des Princes. The principal dish at this dinner was

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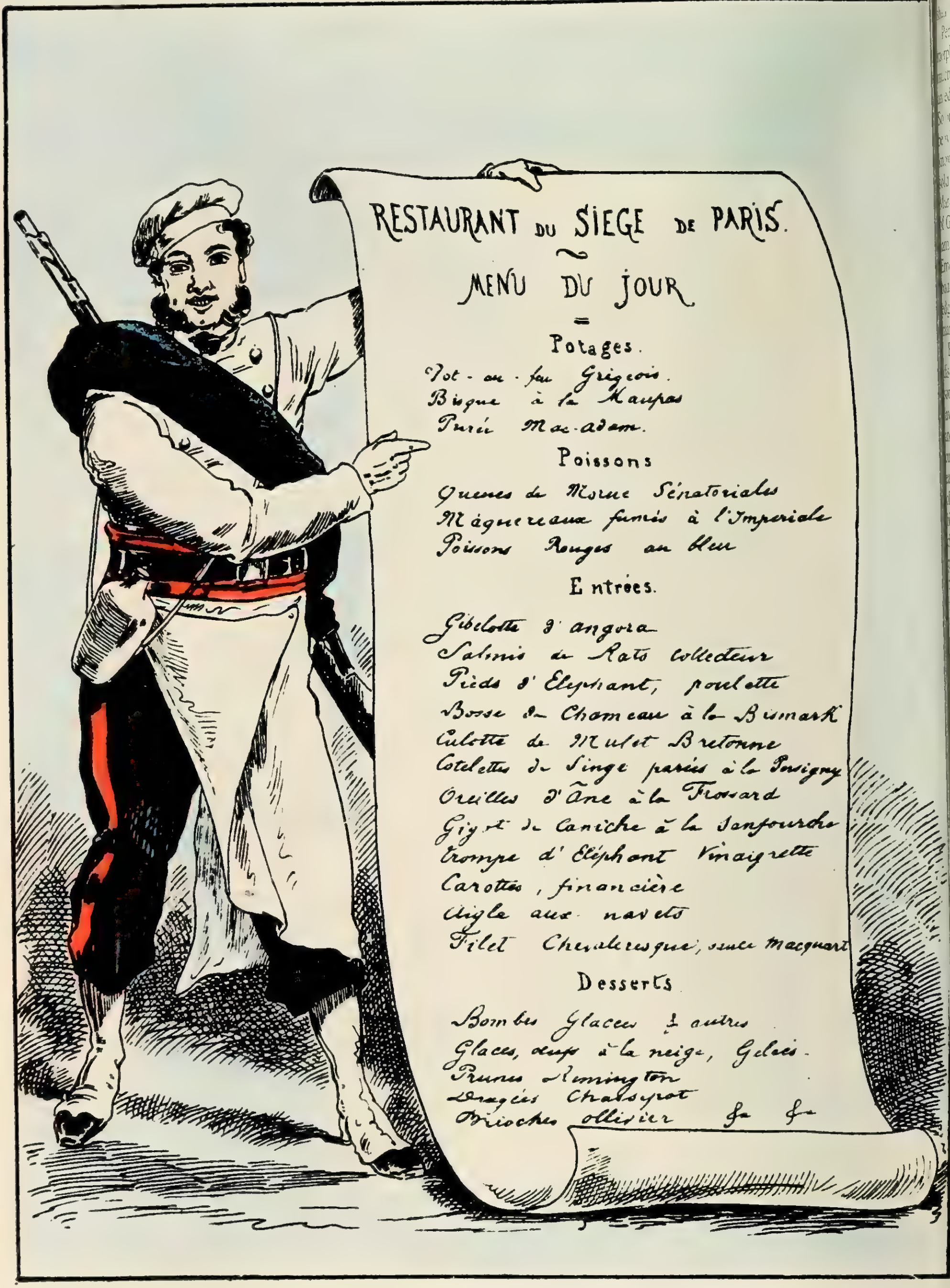

RESTAURANT DU SIEGE DE PARIS.
MENU DU JOUR
Potages.
Pot-au-feu Grégeois.
Bisque à la Maupas
Purée Mac-adam.
Poissons
Queues de Morue Sénatoriales
Mâquereaux fumés à l'Imperiale
Poissons Rouges au bleu
Entrées.
Gibelotte d'angora
Salmis de Rats collecteur
Pieds d'Eléphant, poulette
Bosse de Chameau à la Bismark
Culotte de Mulet Bretonne
Cotelettes de Singe panées à la Persigny
Oreilles d'Âne à la Frossard
Gigot de Caniche à la Sanfourche
Trompe d'Eléphant Vinaigrette
Carottes, financière
Aigle aux navets
Filet Chevaleresque, sauce Macquart
Desserts
Bombes Glacées & autres
Glaces, oeufs à la neige, Gelées.
Prunes Remington
Dragées Chassepot
Brioches Ollivier &c &c

A fanciful siege menu includes such exotic items as a salmi of rat, elephant foot, and camel hump.

scalloped elephant with a sauce of nallots.

Perhaps it was a touch of anthropomorphism, but everything became much more difficult when one knew n edible animal by its given name. o one hungry gentleman found it to e when he ate the heart of a donkey nown as Ernest. Ernest's heart was old by a pale, young girl at the Marché des Ternes, wrapped in one f General Trochu's optimistic proclamations: *Paris ne capitulera pas!* Ernest's heart gave the purchaser a ad case of indigestion that put a new dge on his grudge against the Germans.

Eating the wild beasts, if done indiscriminately, raised for some perons of scruple the rule of Levitical aw: "Whatsoever parteth the hoof, nd is cloven footed, *and* cheweth the ud, among the beasts, that ye shall at." Many verses follow in the Book of Leviticus listing those animals and birds that are forbidden as food, including "whatsoever goeth upon its paws," but when hunger took over, here were dinners to be had based upon English wolf sautéed with mushrooms, entrecôtes of camel as a ubstitute for Christmas turkey, or cold slices of toucan from tropical America, consumed in semidarkness, prinkled with a *brut* champagne. Other zoological novelties from the ardin d'Acclimation, which by no neans exhaust the possibilities, were iger cutlets, boa à la tartare, and narinade of crocodile.

The order in which the animals were sacrificed is interesting. Those considered most valuable were saved until the last. At first only those species of which the zoo possessed two or more specimens were sent to the abattoirs. But this policy was abandoned under the pressure for more animal protein. The hippopotamus was spared for purely economic reasons. No butcher could finance so great a ive weight. Last to be slaughtered were the monkeys. "These were kept alive," wrote an English correspondent for the *London Daily News*, "from a vague and Darwinian notion that they are our relatives, or at least the relatives of some of the members of the Government. . . ." The writer, Henry Labouchere, British but of French Huguenot ancestry, confessed that when he dined upon spaniel he felt like a cannibal. While there are no known instances of anthropophagy during the time Paris was besieged, the idea lingered not far below the level of consciousness. Sometimes it surfaced in a nervous witticism. Adrien Hébrard, director of the moderate liberal republican newspaper, *Le Temps*, while having a dog dinner at Chez Brébart, wondered if they would soon be eating the shepherd.

The bombardment. Often predicted, surely it would come—but when? A German newspaper explained that Bismarck was waiting for the psychological moment. The French laughed over the *moment psychologique* as an example of heavy-handed Teutonic philosophy. The phrase passed into ordinary conversation: "I am hungry. The psychological moment has arrived to dine," or to shave, to carry on some household duty, or whatever. On January 5, 1871, shells began falling in the gardens of the Luxembourg palace, the cemetery of Montparnasse, on the normal school, the Jardin des Plantes, and other locations. The French, more curious than frightened, nodded and said the psychological moment had arrived. There was no panic. Street gamins and the poor picked up and sold the shell fragments. Indeed, a kind of market quotation developed on the souvenirs: a hot piece of metal was worth an extra fifty centimes. Damage from twenty-one days of firing was limited, casualties were light, and there was no terror.

The end was near. The National Guard was filled with martial spirit and self-confidence, yet had never been allowed to fight. At last General Trochu led 100,000 guardsmen on a desperate effort. The attack was made, without feint or any diversionary scheme, in the direction of Montretout and Buzenval where the German positions were especially strong—surely a curious strategy. The Guard retreated in defeat with heavy casualties. It was the day after William I of Prussia was proclaimed Emperor of Germany in the Hall of Mirrors at Versailles. "Never in the history of the world," Washburne wrote, "has an army of half a million men cut such an ignoble figure." Trochu, generally regarded as a military imbecile, and by many as probably a traitor, resigned his military functions. Shortly after the debacle, an angry, radicalized battalion of the National Guard attempted to take possession of the Hôtel de Ville (City Hall) and overturn the government. It was the first time during the terrible year that French troops had fired on Frenchmen.

At the end, famine brought Paris down. The newspapers still dared not mention the idea of surrender, but the rumor spread that by the end of January there would be nothing to eat and that a million people would die before a sack of wheat could be unloaded. A three-week armistice was negotiated, followed by a peace treaty. Under the armistice the city was allowed to reprovision itself. The ordeal had lasted 135 days.

Food was slow in arriving. Great crowds of hungry men, women, and children pressed outward at the city gates, but food trains and carts were met with shrugs and delays at the Prussian forts. When foodstuffs reached the central markets there were riotous scenes and some of the pavilions were looted. Relief ships arrived from both England and the United States and order was gradually restored at the shops. Once more, the fragrant, crusty, wheaten French bread emerged from the ovens of the bakeries, every morsel tasting as though it had been blessed by the Church. The windows at Chevet's were again filled with delightful edibles, and the rat catchers and dog and cat butchers retired into the shadows from which they had emerged.

The people of Paris quickly recovered their physical health. But the accumulation of frustrations, of humiliations, the feeling of betrayal by the responsible authorities, the political and psychological damage were beyond repair. The resistance to the Prussians became transformed into a bloody class struggle between the rebellious Paris Commune and the forces of a conservative national government. During April and May the French fought each other, street by street, barricade by barricade, until the Communards were scattered or dead, while the sound of music from German military bands in the outer forts floated down into the burning city.

But that is another story. ☐

The Case of the Missing Monk Seal

by Peter M. Knudtson

The Caribbean monk seal has not been officially sighted since 1952, yet its survival remains an open question

Candice Bayer; Bruce Coleman, Inc.

No photographs exist of the Caribbean monk seal, although local fishermen periodically claim to have seen the missing animal. It closely resembles the Hawaiian monk seal, left.

In late August 1494, a ship commanded by Christopher Columbus then on his second voyage to the New World, lay anchored off the island o Alta Vela, just south of Haiti. A shor party disembarked and approached th rocky island. On the beach, the chanced upon a herd of eight "se wolves," or seals, each about eight fee long, resting peacefully. Their brow pelages were lightly frosted with gray fading to pale yellow on their stomachs and hoodlike rolls of fat surrounde their retracted necks. They closely resembled the monk seals that some crew members might have seen in th Mediterranean's more familiar waters Astonished by the animals' lack of fear the men crept closer and within a few minutes easily killed all eight.

And so ended, in a prophetically bloody manner, the first recorded encounter between Europeans and the se mammal now known as the Caribbea monk seal, *Monachus tropicalus*. (Species classified in the genus *Monachus* are the only tropical seals.) Caribbea monk seal herds once throve along th shores and islands of the Caribbean an the Gulf of Mexico, but harvested an harassed over the last five centuries their populations have steadily dwindled. By the late eighteenth century, a sighting had become a rare event. Th

st authenticated sighting of a Carib-
an monk seal occurred in 1952 on
rranilla Bank in the western Carib-
an, and the scientific world has all but
nceded the animal's extinction. Ask
most any resident within the monk
al's former range — south from the
ahamas and northern Gulf of Mexico
far as Honduras, east from the
aribbean shores of Mexico and Cen-
al America to Jamaica, Cuba, and
aiti — whether he has ever seen a
al. His answer will almost certainly
no; probably he will softly assure
ou, as if speaking to a foolish child,
at seals are creatures of colder seas
d currents and have never lived in
ese tepid waters.

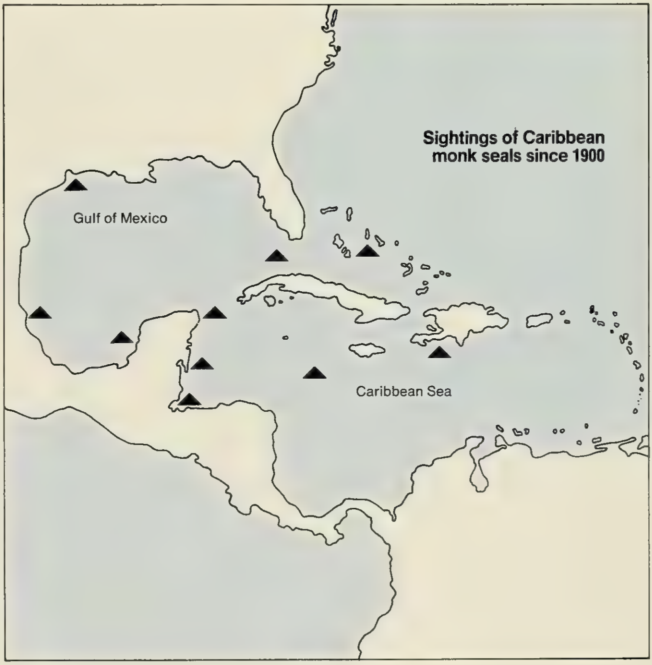
Nevertheless, since 1900 the Carib-
ean monk seal has been seen at various
cations — the Tortuga Islands, Key
est, the Texas coast, the waters off
ingston, Jamaica, and at Isla Mujeres
ear the Yucatan Peninsula. Many of
ese sightings, including several with-
the past two decades, remain uncon-
rmed because a trained scientific ob-
rver was not present; other reports are
earsay or may have been sightings of
her sea mammals in the same waters
- the manatee, *Trichechus manatus,*
hich appears regularly, or the occa-
onal California sea lion that has es-
aped captivity. Yet, persistent seal
ghtings in recent years — infrequent
nd vague as they are — by fishermen
om Yucatan and Belize must, like any
nseen animal's spoor, tantalize even
e most fatalistic biologist.

The Caribbean monk seal's life his-
ory is almost as mysterious as the ques-
on of its current existence. Beyond its
credible lethargy and fearlessness on
nd, and some evidence that single
oal-black woolly pups probably have
een born in parts of the Caribbean in
arly December, we know almost noth-
g of its habits. We do possess some
reserved skin and skeleton specimens,
hich have provided anatomical de-
criptions of monk seal characteristics; for example, an unusual skull shape, four rather than two mammary teats, and structural modifications of the flippers. But specimens did not reach European museums until the mid-nineteenth century when the monk seal population already was depleted.

Some scientists, in their zeal to learn more about the animal, probably contributed to its decline. In December 1886, a joint Mexican-American expedition to study monk seals spent three days on the Triangle Islands west of the Yucatan Peninsula. Although the expedition gathered undeniably valuable scientific data, it killed at least forty seals—and preserved only a fraction of them — at a time when the Triangles were perhaps one of the last breeding grounds of the Caribbean monk seal. Around the turn of the century, collecting for zoos and aquariums resulted in seal deaths in the field and in captivity.

We do know that there are three geographically distinct species of monk seals classified within the genus *Monachus.* By this century, all three species had shrunk to perilously low numbers, although only the Caribbean monk seal seems to have slipped from scientific view. Its widely separated relatives, the Mediterranean monk seal, *M. monachus,* of the Black Sea, the Mediterranean, and adjacent areas, and the Hawaiian monk seal, *M. schauinslandi,* from waters around Hawaii and Laysan, definitely survive, and may number from 1,000 to 5,000 and from 500 to 1,000, respectively.

Monk seals are peculiar among the Pinnipedia (an order of aquatic carnivores that includes seals, sea lions, and walruses) in their year-round preference for tropical seas. In this habitat,


Sightings of Caribbean monk seals since 1900

their conventional pinniped adaptations to cold water, such as insulating coats of blubber and high metabolic rate, would seem a hindrance. We do not know exactly how monk seals reconcile their body plan with their fondness for warm waters; we can only assume that they have evolved physiological and behavioral strategies to avoid overheating.

Judging by similarities in teeth and skeleton, monk seals are most closely related to seals of the Southern Hemisphere — the Weddell, crabeater, leopard, and Ross seals of the Antarctic. Monk seals probably emerged from a parent stock in the Mediterranean, from whence some may have drifted astride the Canary and North Equatorial currents to seed the West Indies with their kind. A few may have penetrated the narrow Isthmus of Panama and eventually crossed the Pacific to the Hawaiian Islands. Reproductively isolated from each other by oceans, these three monk seal populations gradually underwent sufficient independent evolutionary change to warrant their current classification as separate species.

Although Caribbean monk seals must have been hunted previously, they were apparently numerous when the first Europeans arrived. However, from the seventeenth until the late nineteenth century, the seals were relentlessly exploited for the commercially valuable oil produced from their fat. In the early 1700s, a local Bahamian historian indicated the proportions of the rich seal fishery and its potential for destroying its resource: "The Bahamas are filled with seals; sometimes fishers will catch one hundred in a night. They try or melt them and bring off their oil for lamps to these Islands."

Vulnerable on land, like other seals, monk seals suffered a further disadvantage: since seal-hungry predators had not been a part of their tropical environment, the monk seals failed to evolve the innate suspiciousness characteristic of many seals. Disarmed by their own calm dispositions, the sluggish monk seals succumbed when introduced to a new force of natural selection — club-wielding men. And local fishermen have sniped relentlessly at seals, regarding them as competitors for fish, as well as sources of income from blubber, hides, and meat.

Besides these pressures, recent evidence indicates that the ultimate factor in the decline of Caribbean monk seal populations may simply be too many people: seals have been losing their habitat to an expanding human community. In 1973, wildlife biologist Karl W. Kenyon carried out, under the auspices of the Office of Rare and Endangered Species and the U.S. Fish and Wildlife Service, a 4,000-mile aerial search for the Caribbean monk seal. Kenyon reported:

> At every island group visited, we found either fishing vessels or shrimp trawlers at anchor, or fishermen and their shacks on shore, or the remains of abandoned fishermen's camps. We looked without success for any indication of the existence of monk seals . . . my conclusion from the 1973 survey is that the Caribbean monk seal has been extinct from the early 1950s. . . . Even had a few old Caribbean monk seals survived to the 1970s, all available evidence leads me to believe that there is no hope that the species can recover. Man has now dominated its environment.

While the survey is necessarily inconclusive, its failure to locate any remnant monk seal colonies in the most promising parts of its former range must dampen hopes for the Caribbean monk seal's survival. But reliable sightings within the last thirty years, plus other, unconfirmed reports by fishermen, encourage a continued search. During March 1976, I spent two weeks in Honduras, Belize, and Mexico, and ran across several intriguing accounts, along with numerous negative reports, of seal sightings in Caribbean waters. Traveling overland from one coastal fishing town to the next, I questioned local fishermen on the wharfs and in the markets. Many seemed unable to distinguish between manatees, otters, and seals; most, upon studying an illustration I carried, quickly denied the monk seal's existence in the Caribbean. One Belizan conch fisherman insisted that neither he nor his 86-year-old father, in their lifetimes of fishing, had ever seen or heard of seals; my reports to the contrary, he said, were simply lies.

But erratic as they are, reports to the contrary do turn up. A young fisherman from Belize City talked of seeing several very young seals, each weighing about forty pounds, swimming near offshore reefs between Punta Gorda in southern Belize and Livingston, Guatemala. Even there, he admitted, the seals were a very rare sight, visible only at dusk or dawn.

Another fisherman, a middle-aged man from Stann Creek, Belize, spoke confidently of seal sightings some twenty years before on the beaches of the uninhabited Mexican atoll, Chinchorro Reef, east of Yucatan Peninsula. Here, he said, the seals had often proved a nuisance by becoming entangled in turtle nets.

In Chetumal, Mexico, an elderly and obviously poor fisherman mentioned still other seal sightings at Chinchorro Reef, where he claimed to have seen the animals dive from rocks on which they were basking and disappear into underwater caves. Prodding the old man for further details, I patiently explained the seal's plight. Alert to the seal's rarity, the man leaned forward and asked earnestly. "Could a man sell the meat of such a seal for much money?" I was sharply reminded that concern for the welfare of endangered beasts is a luxury to people with empty bellies.

At the very least, these and similar unauthenticated reports of monk seal sightings underline the difficulty of finally establishing a species' extinction. Local fishermen log far more time in the monk seal's waters than most expeditions can afford, and hence their reports could conceivably constitute a sort of grass-roots monitoring system of a remnant breeding colony. In fact, anyone within the Caribbean monk seal's range who spots a nearly uniform brown seal, without apparent external ears, tinged with gray and fading to pale yellow or yellow-white ventrally, measuring six to nine feet from nose to tail, and weighing perhaps 550 pounds should photograph and report it to local and international conservation authorities. (The Marine Mammal and Endangered Species Division, National Marine Fisheries Service, Washington, D.C. 20235, has legal jurisdiction over the Caribbean monk seal.)

The case of another supposedly extinct seal, the Juan Fernández fur seal, *Arctocephalus philippii*, of South

As typical pinnipeds, the Caribbean monk seal and its Hawaiian relative, right, could live comfortably in cold waters. Yet both species prefer tropical seas year-round.

Russ Kinne, Photo Researchers

America, may serve as an inspiration in the search for the Caribbean monk seal. Once common on a cluster of islands some 400 miles off the coast of Chile, the Juan Fernández fur seal also suffered terrible commercial exploitation, beginning in the eighteenth century. By 1900, the species had been all but eliminated from its island range.

While scientists were lamenting the fur seal's disappearance, Chilean fishermen of the Juan Fernández Islands continued to encounter them from time to time in remote fishing grounds. Not until 1958, when a series of documented fur seal sightings began, did the scientific community begin to accept the "rediscovery" of the Juan Fernández fur seal. Reduced to several hundred, and inclined to retreat to isolated sea caves when disturbed, the seals had for a time been lost to scientists, but to sharp-eyed resident fishermen, the animals had never completely vanished.

However, the monk seal's critical vulnerability to human disturbance and harassment, especially during the breeding season — and the amount of human activity in the Caribbean — weaken the animal's chances of survival. Monk seals, it appears, simply will not breed successfully in the face of continual human disturbance, which poses a serious problem in their management. The case of the missing Caribbean monk seal may be another instance of international concern arriving too late. Had recent proposals for a monk seal breeding sanctuary been put forward and acted upon early in this century, a more optimistic prognosis for the species might be possible.

Although its memory lingers fresh and close, the Caribbean monk seal will probably remain a stranger. And at times, I find myself wondering what dark and fleeting image of species-end might have passed — barely sensed like a frigate bird's shadow—before the eyes of a monk seal as it lay, not long ago, on the sands of some remote Caribbean key. ☐

Hawaiian monk seals bask in South Pacific sunlight. On land, all seals are easy prey, but Caribbean monk seals, in particular, were decimated because they failed to recognize humans as predators. Another threat to their survival is that monk seals simply will not breed if disturbed by people. In the well-traveled Caribbean, remote retreats are now very few.

Candice Bayer; Bruce Coleman, Inc.

George Raycock, Photo Researchers

kin Batteries
nd Limb Regeneration

y Richard B. Borgens

ioelectricity is the key
growing a new foot

Losing a limb would be disastrous r most animals. But a large number of ecies — worms, fish, lizards, and ckroaches, to name but a few — are le to replace certain parts of their dies if they are lost. Some animals ve even evolved the regeneration of a st appendage as a defense mechasm. The tails of some lizards, for ample, have built-in breaking points; hen seized by a predator, the lizard's il separates from its body. The predor is left with a small meal, while the zard is usually able to scamper off and entually regrow what the predator ok.

For several years, I have studied the markable regenerative abilities of wts and other salamanders. When rtain species of salamanders lose a nb, they grow a replacement that will a nearly perfect copy of the original. his capability, common to most tailed nphibians, has been a puzzle to sciensts because there are no obvious difrences between the tissues of these nimals and those of vertebrates that are nable to regenerate lost body parts. On histological level, the same types of structural and functional tissues make up the limbs of salamanders and those of humans. Yet, the regenerative power of newts and salamanders is virtually limitless. For example, a surgically removed salamander's retina will regenerate and perfect vision will be restored to the animal.

hen seized by a predator, the ailing appendage of a long-tailed lamander breaks away, allowing e animal to escape. The salamander en grows a new tail, which will e a replica of the old one.

zozynski; Animals, Animals

Much has been learned about the regeneration process since the first modern description in 1769 by Lazzaro Spallanzani, an Italian naturalist who worked with newts, salamanders, and other animals. The changes that take place after the amputation of a salamander's limb serve to characterize the sequence of events during regeneration. After amputation, the tip of the stump quickly becomes covered with a thin, transparent wound epithelium, which seals off the lesion from the external environment. Internally, the damaged tissues of the appendage are cytolyzed and removed by the body's natural "cleanup" mechanism, and the remaining healthy cells begin a process called dedifferentiation. This means that many of the subepidermal tissues of the stump tip begin to lose the morphological characteristics that distinguish them from each other. Cartilage, bone, and muscle tissues regress to a cell type resembling the embryonic mesenchyme (unspecialized mesodermal connective tissue) from which all were derived. The resultant homogeneous mass of mesenchymatous cells, with its epithelial covering, is called a blastema.

The blastema, after reaching a certain size, then redifferentiates. It reorganizes and develops back into a replica of the severed portion of the limb. The length of time needed for this body repair is variable, depending on the season of the year, and the age and particular species of salamander. In general, a fine forelimb, with only minor differentiation still in progress, is produced in two to four months.

Experimental limb amputations in salamanders and adult grass frogs, a related but nonregenerating species, have provided clues to the factors controlling the power of regeneration. A classic example is the pioneering work of biologist-anatomist Marcus Singer, who deciphered the relationship between nerve supply to the limbs of salamanders and grass frogs and their ability to regenerate. Singer has shown that a critical relationship must exist between the cross-sectional surface area of nerve tissue at the stump tip and the total area of the amputation surface. In salamanders, if enough nerves leading to the stump are cut away so that this ratio is lowered to a certain point, the limb will not regenerate. Adult grass frogs, like other nonregenerating vertebrates, are naturally deficient in this axoplasmic ratio. However, if an extra large nerve, such as the sciatic nerve of the leg, is surgically rerouted to the stump of a grass frog's amputated limb, the appendage will begin to regenerate. (The limb does not regrow fully, however, and what does regenerate is deficient in internal structure and organization and atypical in outward appearance.)

Other experimental methods have been successful in promoting regeneration in grass frogs, namely, immersion of an amputated stump in aqueous solutions of sodium chloride (table salt),

Richard B. Borgens

Eleven weeks after amputation, the forelimb of a tiger salamander has developed well through natural regeneration. The regrowth process can be blocked with a drug that shuts off the skin battery.

the surgical implantation of extra adrenal glands, and electrically stimulating the nerves servicing the forearm stump.

One of the most provocative recent experiments dealing with the induction of regeneration in frogs was performed by Stephen D. Smith of the University of Kentucky Medical School. Smith implanted (for experimental convenience) small electrical stimulation units, made from hearing-aid batteries, into the backs of adult frogs (*Rana pipiens*). With an insulated wire, he directed minuscule levels of current (100 billionths of an ampere) to the amputated forearm stumps of the frogs. In four weeks, the batteries were removed and the forearms began to regenerate.

This experiment caught the attention of Lionel Jaffe, a scientist whose major research has demonstrated how naturally produced electricity helps shape the development and modify the growth of a variety of plant and animal cells. Primarily an embryologist, Jaffe has proved that certain types of cells act like miniature batteries, driving electrical currents through themselves and setting up a natural, stable DC electrical field. (This is not to be confused with nerve activity, which produces a rapid, transient electrical event, or with the membrane potential of all living cells, which is, in an electrical sense, more similar to a capacitor than a battery.) His laboratory at Purdue University developed a remarkable tool, the vibrating probe, to measure these tiny, naturally produced electrical fields. Jaffe, developmental biologist Joseph Vanable, Jr., and I felt that the startling results of battery implants on frogs provided evidence for a direct connection between self-produced electricity and regeneration.

The first step was to demonstrate that the regeneration promoted in adult frogs was, in fact, caused by electricity. All the methods that had been used to stimulate tissues electrically relied on metal wires. Whether the regeneration effect was due to the electricity or to electrode byproducts was unclear. The effect might have been caused by chemical compounds that form when electricity passes through metal into a conductive solution such as body fluids.

To answer this question, we developed a nonmetallic, fluid-filled stimulating electrode that would be free from byproduct contaminants. Current was carried by this "aqueous wire" to the surface of amputated grass frog limbs through a salt solution, similar to body fluids, insulated by a jacket of biologically inert silicon polymer.

Having eliminated the chance of electrode byproduct contamination, we achieved results comparable to Smith's: organized extension of the forearm bone, abundant new muscle, large quantities of new nerve tissue, and development of cartilage masses resembling the bones of the wrist and hand. In all cases where the stimulating electrode (lead) was negative, regeneration was initiated. (Interestingly, if the positive lead was used, the opposite effect occurred—severe tissue destruction of the forelimb.)

Two years of experimentation did not, however, support a report, widel circulated in the popular press, of "pe fect" limb replacement in adult frogs b electrical means. Although perfectio was not reached, the frogs certainl produced more than if left to their ow devices. This, plus the amazingly lo current employed, made us look mor closely at salamanders. Could self-generated electrical currents account fo their ability to regenerate lost bod parts?

The notion that electricity plays role in the normal replacement of salamander limbs dates back to 1905, whe biologist Oren E. Frazee unsuccessfully attempted to influence regeneration with imposed electric fields. Actual electrical measurements were attempted in 1940 by biologist Albert Monroy in Naples. He measured voltage differences along the surface o limb stumps, from the shoulder to th tip. These translimb differences in electrical potential (since noticed by othe investigators) yielded no informatio about the actual flow of current bu provided provocative indications tha natural electrical currents existed. T settle the issue of current flow, the vibrating probe was used. The flow o current was measured around the regenerating forelimbs of red-spotte newts. In a biological sense, the curren densities were enormous, often reaching 100 microamperes per square centimeter. The path of the current arce from the end of the stump and reentere the animal's body and the shank of it forelimb. These currents persisted fo the first two weeks after amputation an seemed to mark the location of the budding blastema.

The measurements of current flov raised a number of exciting questions yet one thing was certain: from inception, the normal regeneration of appendages in salamanders is a highly electrically active event.

Three major questions arose: What i the source of the animal's electricity' How necessary for regeneration are th naturally produced electrical fields? I the fields are required, what tissues d they affect? Further experiments wit the salamanders helped us answer tw of these questions.

The source of electricity was th simplest question to approach experimentally. Nerves are certainly electrically active and might be the source o the current we had measured. Any ver rate limb can be rendered nerveless clipping its spinal nerve supply. onroy's voltage measurements dem- strated that nerves could not be the urce of the electrical regeneration rrents since the presence or absence the majority of nerves in the arm did t affect his readings. Although a later vestigator insisted that nerves were source of the voltage differences, vibrating probe measurements con- med Monroy's findings: no change in ctrical activity was noted after nerve nsection.

Amphibians possess another electri- lly active tissue, the skin, that oper- es like a battery. The skin of most nphibians possesses a sodium- ecific transport system, which moves dium from the water on the skin's rface into the body. In effect, the nsport system acts as a complicated, dium-dependent "pump" that drives ong electric currents.

The "skin battery's" sodium de- ndence provided us with a test of hether the skin is the source of the generation currents. Using red- otted newts, we deprived their skin of dium (either through the use of chem- als that block the sodium channels or simply placing the animal in sodi- n-free water), and so were able to turn f their skin batteries.

By increasing sodium well above the rmal levels found in pond water, we ere able to increase the magnitude of e currents. With these inhibition and odulation techniques, we have been le to prove that the skin surrounding e remainder of the amputated appen- ge, and perhaps some of the body, is e source of this electrical activity.

The same approach was used to test e necessity of these currents for re- neration. The experiments are still in ogress, but one thing is clear—limb generation can be severely disrupted techniques that shut off the skin bat- ry current and its associated field.

In one such experiment, the diuretic

Frogs lose the ability to regenerate dy parts during metamorphosis from the tadpole stage. Regeneration can be induced experimentally, however, through the use of electricity, salt baths, and rerouting of nerves.

Dan Budnik, Woodfin Camp & Associates

ug amiloride was applied only to the
ff of skin surrounding the forelimb
umps of tiger salamanders. Amiloride
pplied this way specifically blocks the
dium channels of the outer layers of
in, thereby turning off the skin bat-
ry. Fifty percent of the animals so
ated were inhibited from regenerat-
g or regenerated grotesque facsimiles
a forearm and hand. Preliminary
idence also shows that most animals
e either inhibited from regenerating
do not regenerate normally if kept in
ow-sodium medium, while those in a
gh-sodium medium regenerate ex-
ordinarily fast. We can now begin to
ake sense of how immersions in salt
lutions are able to initiate regenera-
n in grass frogs: the electrical output
their skin batteries was stimulated
d increased by the presence of more
lt than is found in the pond water
habited by the frogs.

We know that the natural replace-
ent of body parts in salamanders is
eceded by a period of high electrical
tivity, during which a naturally pro-
ced electric field is set up around the
nb stump. We also have some evi-
ence that such a field is necessary for
rmal regeneration in these animals
d that artificially stimulating the
ump of nonregenerating adult frogs
ill partially restore their regenerative
pabilities.

We do not know what the cellular
rget(s) of this current might be, but
e have some guesses. Ironically, al-
ough nerve tissue is not a source, it
ay prove to be the target of the cur-
nt. Studies of embryonic chicken
nglia have shown that the direction of
owth of new nerve processes can be
ntrolled by weak electric fields.
erhaps nerves (which are also essen-
al for regeneration) are directed by
ese natural fields into the region
here they influence blastema forma-
on.

Another unanswered question con-
erns the electrical behavior of the limb stump in frogs. Adult frog skin also acts as a sodium-dependent battery, yet these animals do not regenerate. (The vibrating probe is now being modified to permit measurements on these animals.) Preliminary work suggests that the current exiting from the stump of adult frogs is one-tenth the magnitude of that in salamanders—possibly frogs are "shorted out" internally. This may well prove to be true: beneath a frog's skin are large lymph pockets that do not exist in salamanders. The lymph may short circuit the flow of electricity around, and not through, the internal tissues of the stump.

'aving lost its tail either
ccidentally or by predation, a
d-backed salamander is growing
new one (dark segment at end of
ump.) Not all species of
alamanders have this ability.

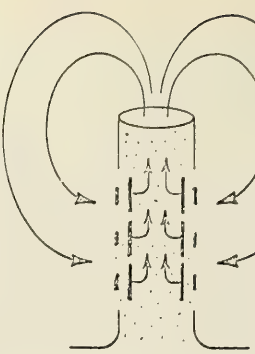
Researchers

Human beings, like all vertebrates, are not complete nonregenerators. Skin, bone, and parts of other organs and tissues of our bodies replace themselves as a normal part of the life process. Yet the ability to form functional tissue, instead of nonfunctional scar tissue, or to replace missing portions of the body is greatly restricted in all vertebrates except the tailed amphibians. To discover some of the critical factors separating the two groups would have the most profound medical consequences. Bioelectricity certainly seems to be one factor.

At present, some success is being achieved in healing chronic nonunions of human bone fractures by stimulating the fracture sites with low levels of current. Electricity has also been used to aid the healing of bed sores. Replacement of articular cartilage through electrical stimulation has been accomplished in rabbits, and the technique may soon find practical applications in hospitals.

There is a parallel between humans and nonregenerating amphibians that also demands close scrutiny. Although adult frogs do not regenerate portions of their appendages, tadpoles do. They lose this ability during metamorphosis. Adult humans, of course, do not replace portions of their extremities, yet it is not well known that children do!

Pediatricians Cynthia Illingworth of England and B.S. Douglas of Australia have demonstrated that children (up to eleven years of age) can perfectly regenerate the tips of their fingers from past the first joint. The cosmetic results are remarkable, including well-formed fingernails. This extraordinary result was achieved without any experimental intervention. The fingers were simply splinted and bandaged, without surgical tampering, and nature did the rest.



Internally produced electricity arcs out of the tip of a diagrammatic salamander limb. The currents flowing back along the shank of the limb create an electrical field before they reenter the animal. Sodium-driven "batteries" in the salamander's skin are the source of this electricity, which seems to be the agent promoting the regeneration of lost appendages in these amphibians.

Nothing is known about whether electricity plays a role in the finger regeneration of children. Interestingly enough, before the American Civil War, physiologist E. Du Bois-Reymond discovered that natural currents emanate from wounds of human skin. In light of our data, the existence of these currents suggests that they may aid in wound healing and, conceivably, finger regeneration.

Humans apparently also lose their regenerative ability as they mature. Could bioelectricity be involved in regaining this ability, as it certainly is in frogs?

We may well hope that biological research in amphibian regeneration will someday deliver tools to modern medicine for making tissue-regeneration therapy a normal part of hospital procedure. This may sound more like science fiction than science fact, yet it is certainly possible that latent in human beings is the promise of whole-tissue regeneration so elegantly realized in the tailed amphibians. ☐

Three, Two, One Tortoise

/ Peter C.H. Pritchard

e giant Pinta Island rtoise, thought to be tinct for many years, ll survives in the alápagos. But only a single ecimen has been found

On a clear tropical evening in early 72, my wife, Sibille, and I were joying dinner with Dr. Joseph Vaglgyi, a Hungarian-American auority on land snails, in his tiny cotge on Santa Cruz Island in the alápagos. As often happens when ientists convene socially in the alápagos, the conversation drifted the subject of giant tortoises, and ce I was the turtle specialist and seph was the malacologist, I was ing most of the talking.

"The tortoises with normal, domeaped shells live on the lush higher ands where they are never short of od," I explained. "But on the all, lower, dry islands, the torises have evolved long legs and a ised shell front—the famous 'sadeback shell'—so they can reach gher for food, since the ground vel vegetation is not enough to susin them. The one exception to this pears to be the tortoise of Pinta ormerly Abingdon] Island, which s an extremely saddle-backed shell t which lives on a relatively high land with lush vegetation in the inter."

Joseph interrupted quietly at this point. "But the tortoise we saw on Pinta last month did not have a particularly saddle-backed shell." My jaw dropped. Not because of the shape of the tortoise—that was irrelevant for the moment—but because the Pinta tortoise, *Geochelone elephantopus abingdoni,* had not been seen alive for fifty years.

I questioned Joseph closely. Yes, he had taken photographs of the tortoise, which he had encountered on December 1 in the upper part of the arid zone on the southern slopes of the island. The tortoise had not impressed him as being particularly large or strikingly saddle-backed. He promised to send me photos when he returned to the United States a few months later.

I found it a little hard to concentrate on social pleasantries the rest of the evening. The Pinta tortoise was not just one of about fifteen subspecies of giant tortoise in the Galápagos Islands; to me, it was the focus of a boyhood dream. Thirteen years earlier, when I was a turtle-obsessed teen-ager in, of all places, Northern Ireland, my parents had given me for my birthday a copy of Albert Gunther's classic monograph *Gigantic Land Tortoises,* published by the British Museum in 1877. This ponderous Victorian work was liberally illustrated with enormously detailed engravings of various giant tortoises and their bones. But the one that caught my attention showed a peculiar beast whose shell looked more like a wrinkled, leathery mantle than a true carapace, and whose long, stout neck, raised straight up, carried a tiny head with expressionless eyes.

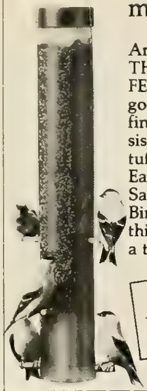
The text indicated that the drawings were based on three tortoises collected on then named Abingdon Island by one Capt. James Cookson and presented to the British Museum in June 1876. Cookson had tried to bring them back alive, but had not succeeded; he concluded that their extraordinarily thin shells rendered them especially liable to blows, falls, and other rough treatment, and they were therefore unable to survive the rigors of a sea voyage. Gunther agreed with this opinion. But since the tortoises had been collected on the island so recently a population obviously still existed there.

But that was in 1877—82 years before Gunther's book fell into my hands. Galápagos tortoises in general were known to be suffering from the depredations of humans and introduced pigs, dogs, and competing herbivorous animals (notably goats), but the Galápagos were highly inaccessible before the 1960s, and the few scientists who went there had more than enough to hold their attention in the central islands without spending the time and money to visit remote Pinta.

I resolved that some day I would lead an expedition to try and find any survivors of this prehistoric-looking creature. During my Oxford years, this dream was kept alive by a signpost indicating the mileage to the nearby town of Abingdon. That ancient but prosaic English city had no special interest to me; but the signpost regularly reminded me of its faraway namesake in the tropical Pacific.

The island first appeared on maps

es Darwin Research Station,
esy of World Wildlife Fund



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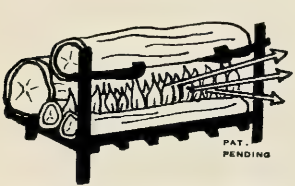

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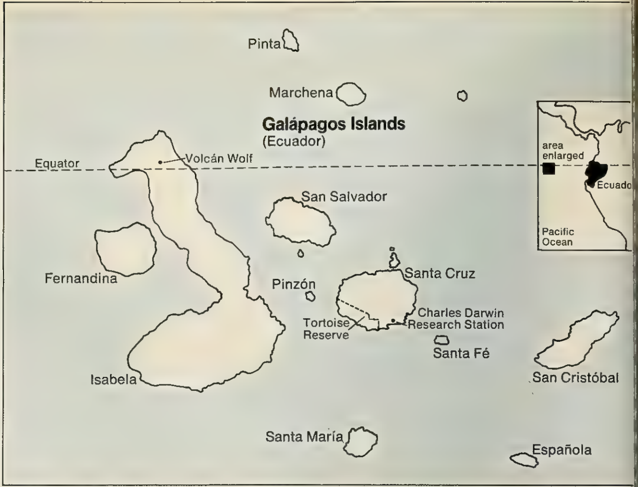

in 1684, when the buccaneer William Ambrose Cowley published a chart of the "Gallapagos Islands." It was shown as the "Earl of Abingdon's Island," and was considerably exaggerated in size, nearly the same size as the Duke of Norfolk's Island (now known as Santa Cruz, which is, in fact, several times larger than Pinta). Details included a South Bay and an East Bay, as well as the Norias Rocks, off the northern tip, and Rycot Rock to the west.

The fact that a pirate such as Ambrose Cowley should have named many of the Galápagos Islands after the establishment figures and royalty of England is worth a little explanation. At the time, England was not actually at war with Spain, and it was theoretically British policy to cooperate with Spain in suppressing the bu caneers. Nevertheless, the raids Cowley and the other buccaneers the time were directed against Spa ish rather than English ships, and tl royal decrees against piracy, hal heartedly issued in the first plac were virtually ignored by the Engli New World administrators in Be muda, Nassau, and Jamaica. Cowl showed his appreciation for this tole

The last known Pinta Island tortoise makes final tracks on his native island shortly before he was deported to the Charles Darwin Research Station for safety reasons.

Peter C. H. Pritch

t attitude by naming the islands
er his friends in high places. It was
t until many years later that the
uadoreans renamed Abingdon, Isla
nta.

From the time of the discovery of
nta Island, buccaneers and other vis-
rs undoubtedly collected tortoises
re. The first extant record of such
llecting, however, is for January
22, when Capt. Basil Hall visited
island. He wrote in his 1840 pub-
ation, *Extracts of a Journal Writ-*
n on the Coasts of Chili, Peru, and
exico, in the Years 1820, 1821,
d 1822: "We took some [tortoises]
board which lived for many
onths, but none of them survived
cold weather off Cape Horn. I pre-
ved one in a cask of spirits, and it
ay now be seen in the Museum of
College at Edinburgh; it is about
medium size."

The real depredations of the Pinta
toise population took place during
mid-nineteenth century, when
naling ships based in Massachusetts
re in the habit of stocking up with
lápagos tortoises, thereby insuring
supply of fresh meat while at sea.
ne tortoises of the smaller islands
re favored for such operations be-
use they were more accessible and
cause they tended to be smaller,
d thus, more manageable; the huge
toises of Santa Cruz and Isabe-
islands were not heavily exploited
til permanent settlements were
ablished on those islands.

In the 1920s zoologist Charles
wnsend undertook a detailed anal-
is of the logbooks of the American
naling fleet, and while each island
ust have been raided many more
nes than indicated in the records
at came to Townsend's attention,
research nevertheless gives an
ea of the intensity of tortoise ex-
oitation and also the point in history
which their populations collapsed.
r example, a single ship, the *Abi-*
il, collected 142 tortoises on a visit
Pinta in 1837, and sixty-seven were
llected by the *Hector* in 1843. Thir-
three were known to have been col-
cted by two ships in 1848, but
early this was the last of the big
uls as no subsequent ship's crew
as able to locate more than six indi-
duals.

When Captain Cookson visited the
and in 1875, he found only four
toises after an extensive search. He
ote: "Tortoises were never, I be-
ve, very abundant on Abingdon Is-
nd; our searching party found four

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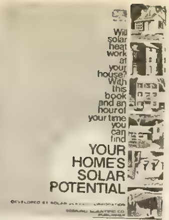
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on the island. They were on the hi
ground; and it was a work of gre
labour getting them down to t
boats. The distance was about fo
miles; but the ground was excee
ingly rugged, and covered with thi
brush, through which a trail had to
cut for the entire distance. The large
found on this island weighed 2
pounds, and the smallest 1
pounds."

Thirty years later the tortois
were, if anything, rarer still. Rol
Beck, perhaps the most energet
Galápagos explorer and tortoise co
lector who ever lived, wrote in 190

> So far as known, *Testudo abingdoni*,
> Abingdon Island, is practically extin
> We secured two specimens in 1901, b
> on another trip, after thoroughly hunti
> over the ground where tortoises were fo
> merly common, only a single fresh tr
> was discovered, where a lone tortoise h
> passed a few months before. The part
> the island where this species lived is fai
> easy to travel over, and therefore it w
> not a difficult matter for the hunters wi
> dogs to make a clean sweep. While the
> are about forty square miles of surface
> this island, not over seven or eight a
> suitable for tortoises, and for some of t
> other species the proportion of suitab
> ground is still less.

Beck had an exaggerated idea of t
total area of Pinta Island (twenty-thr
square miles) but he was right in co
cluding that only a small part of it w
suitable for tortoises. Zoologist-e
plorer Edmund Heller wrote of t
Pinta tortoise in 1901:

> Probably now nearly extinct. None se
> by us in June 1899, on the northwe
> slope of Abingdon. The northern a
> northwestern slopes of the island were e
> plored by us from sea level to summit
> highest peak without finding even a tra
> of the present or past existence of *Te*
> *tudo*. What tortoises now remain on t
> island are probably confined to the moi
> ter and greener southern slopes where t
> *Albatross* and *Petrel* secured their spec
> mens.

The last record of live tortoises o
Pinta—until Joseph Vagvolgyi foun
the single survivor in 1972—was i
1906. The California Academy
Sciences expedition, aboard th
schooner *Academy*, spent a full ye
in the archipelago and several days i
September 1906 were spent on Pint
Three tortoises were found. The fie
notes taken by J. R. Slevin includ
the following entry for September 2

> Went in after the tortoise which Bec
> found September 19. It was about a mi
> or two above the green zone on the sout
> ern slope of the mountain. Up there it

nually raining or foggy throughout norning, but clears off in the after-. It is capital tortoise country, every- being green, with plenty of water actus. The three tortoises taken were fat, and showed the effects of good g. We saw no other signs, and they ably are very rare on Abingdon Is- The stomach of the one collected contained grass and cactus. Beck found an old shell and a few bones ave, where the tortoise probably had n in and died. We carried these n, and they are in fairly good condi-

s with the Cookson specimens, three tortoises collected were t males (all were killed for scien- specimens). In fact, there was one female tortoise from this is- to be found in any museum col- on. This was a young individual cted by Rollo Beck in 1901 and osited in the collection of Walter nschild, a celebrated and wealthy ent of giant tortoises, at Tring, land. The Academy party noted while the tortoises collected ap- ed to be fat and in good condi-, they were very rare, and no s were found of any individuals r than the three collected.

omehow a minuscule population rtoises lingered on Pinta through de after decade of the twentieth ury. The apparent failure of the ulation to increase undoubtedly ved from the virtually complete ination of females by whalers. lers preferred the smaller fe- s because they were easier to y; also, females were probably er to find because more of them ld be at lower elevations, at least ng the nesting season. On the r hand, giant tortoises live a great th of time—probably more a century—and since the habitat ained essentially undisturbed 1958 or 1959, the Pinta Island ise did not die out completely.

or half a century after the Califor- Academy expedition, Pinta re- ned unvisited by scientific parties was probably little visited by any- In 1957 a joint Galápagos expe- n by UNESCO and *Life* maga- was undertaken. Biologists Rob- Bowman and Irenäus Eibl-Eibes- t climbed part of the way up the d. They did not find tortoises, but were not ashore for very long. ewhat optimistically, the two reasoned that since the island seldom visited by man and was ely free of introduced animals, ortoises must still be present and

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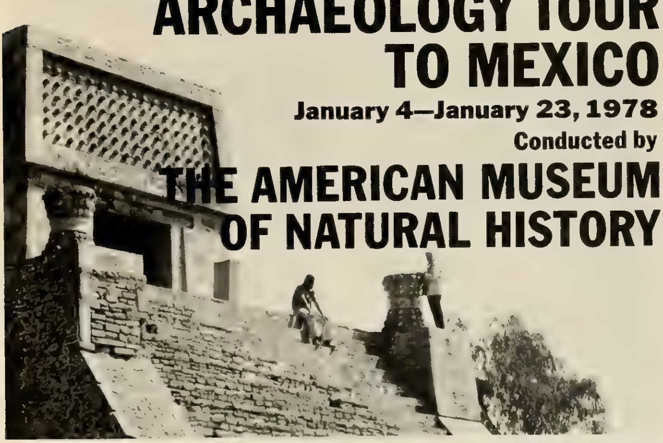

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might well recover. They even foun what looked like an old tortoise trail

A recovery of the tortoise population on Pinta Island might have take place, but a year or two later, disaste struck. A Galápagos settler from th island of San Cristobal introduce three goats to Pinta, hoping to establish a population of these animals tha would provide fishermen such as himself with red meat when fishing in th vicinity of the island. The introduction succeeded beyond his wildes dreams. In March 1963 biologists E Curio and Peter Kramer camped fo three weeks on Pinta and found th goats to be locally numerous. In Ma 1964 Miguel Castro, a native of th Galápagos who had for years studie the tortoise populations on a numbe of islands, and biologist David Cavagnaro camped on Pinta for nin days searching for tortoises. The found that the goats had already adversely affected the vegetation of th lower areas on the south side of th island where the tortoises were supposed to live—indeed it is about th only suitable area for tortoises, muc of Pinta being relatively fresh, unvegetated lava.

Castro and Cavagnaro found n living specimens, but chancing t look into a deep fissure in the groun shortly before they left the island they found the remains of a dead tortoise. They spent the next two day looking in similar fissures and foun skeletons of twenty-seven more tortoises. Undoubtedly, the goats, b feeding on all the low-growing vegetation in the lowlands, had forced th tortoises to climb higher in search o food; at the higher altitudes, wher the treacherous fissures were obscured by thick grass, the tortoise had tumbled in one by one and died

It was 1971 before the Ecuadorea Park Service, which oversees operations of Galápagos National Park was sufficiently organized and funde to embark on a program to eliminat the goats from Pinta. By then th goats had reached plague proportions. Although the tortoises appeared to be extinct, the extermination campaign was still necessar because the island harbored numerous endemic plant species tha were also severely affected by th goats. In the course of repeated visit to Pinta in 1971, 1972, and 1973 33,052 goats were killed and left t rot. The program has continued eve since, but as of June 1975 there wer still an estimated 10,000 to 15,00

l goats surviving on the island.
After Vagvolgyi's dramatic revela-
n, I resolved that the time had
ne to look for a Pinta tortoise my-
f, even though I was in the
lápagos, not to look for tortoises,
to investigate sea turtles. Time in
islands was precious, and I could
drop everything for a tortoise
nt. Nevertheless, it was important
me to visit shorelines of as many
nds as possible, including Pinta,
search for sea turtle nesting areas.
ta is rarely visited by scientists
tly because the journey is an ex-
nsive, two-day boat charter from
Darwin Station base on Santa
z Island, so when I learned that
arty led by Ole Hamann, a Danish
anist, was leaving in two weeks to
nd five days on the island, I
ckly arranged to share his charter.

Galápagos navigators eschew
uipment more sophisticated than a
npass because it cannot be
aired in the islands; they usually
vigate by the simple technique of
nting the boat in approximately
right direction and hoping that an
nd will come into sight before the
e just passed disappears. The spac-
of the islands is such that this
ategy works well except when fog
cends; then things can become un-
tling. But as we slowly chugged
th, with dolphins cavorting in our
w wave, the day remained clear,
l we saw the long, low profile of
m Marchena Island to the right,
n Pinta straight ahead, before
nes Island vanished behind us.

A party of park wardens had been
work shooting goats on Pinta be-
e we arrived; they were going back
Santa Cruz in our boat the next
rning. Ole Hamann was able to
tact them by radio. After a long
versation, during which I admired
fluent Spanish with a strong Scan-
avian lilt, he came over to me, his
e beaming. "They have found a
toise—a large male!" he an-
unced. The fulfillment of my
am, to see a live tortoise on Pinta
and, was imminent; it was margin-
y clouded because it had been
nd by someone else, but this ego-
ical worry faded since this large
ividual clearly could not be the
Vagvolgyi found. Thus there was
l hope that a potential breeding
r existed.

For the remaining hours, I paced
boat as we drew closer to Pinta.
e island showed a broad, evenly
ept profile, with a central peak, a

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lesser mountain to the left, and an isolated tuff cone rising out of a bed of raw lava on the extreme right. We steered for the landing place and campsite at the border of the fresh lava flow. By late afternoon, we were able to see the goat-ravaged lower slopes of the island, with only the mature cactus trees standing above the wasteland. We anchored and went ashore. I asked the goat control party where they had put the tortoise, and they directed me to where it was tethered to a small tree by one hind foot.

I was, at first, disappointed. It looked too ordinary. True, the shell was raised in the front into a handsome saddle shape; but the animal, although mature, was relatively young—still growing, as could be judged by the fresh, light annuli around each of the big shell plates—and it lacked the antediluvian look of Gunther's old engravings. But when the animal raised its head three feet in the air, I recognized the primeval stare of the British Museum specimens.

It was nearly dusk, but Ole and I carried the animal out into the open for photographs. It doggedly lumbered back to its hiding place, appearing, as saddleback tortoises often do, to have an instability about its gait that suggested leg injury or deformity. But it was perfectly healthy. The next day the wardens left for Santa Cruz and took the tortoise with them, lest it, too, should fall into a hidden ravine and die. The only survivor of thousands of years of evolution was carried down to the little beach and dumped upside down in the dinghy to be rowed out to the boat.

I surveyed the Pinta beaches for sea turtle signs the next day, but found very little. One of the beaches seemed to have an old track and nest pit, but I could not be sure that the spoor had been made by a sea turtle or by one of the many sea lions that honked and barked at me as I wandered down the coast. Certainly no aggregated nesting took place here. So I turned my attention inland during the remainder of my stay. On the third day, my assistant, Patty Ottens, and I climbed to the top of the island—a feat that had been an all-day machete-slashing operation before the goats took over, but which was now a relatively easy three-hour walk.

We came down slowly, past the area where the ground was deeply fissured by the ravines that Castro and Cavagnaro had found to be tortoise

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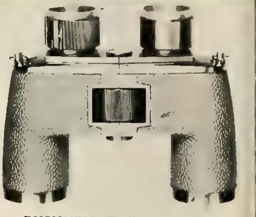

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athtraps. I had no intention of de-ending into one, but I clumsily opped a camera lens; it rolled over y foot and down into the fissure. I entually worked out a method of tting down and up safely, and while covering the lens looked around for rtoise remains, but none were to be und. In the years since 1964, they d crumbled to dust. A little farther wn the slope, we found tortoise nes—first the skull, neck bones, d carapace fragments of what had ost likely been a large male tortoise; en the intact bony carapace of an-her individual that presumably was mature female, judging by its small size and fully closed shell sutures. ese shells must have been only a w years old. The shell of the female owed machete marks across the idges where the belly shell had been moved; she had been killed by a an. The utter senselessness of it al-ost reduced me to tears. We were itnesses to the final extinction of a amatic and wonderful form of ani-al life. Instead of poaching one of e more numerous tortoises on a ore accessible island like Santa ruz—or, better still, obtaining his eat from one of the goats that ttlers were encouraged to kill—a rverse and evil man had made the ng journey to Abingdon, climbed e mountain, and finding a single tor-ise, had turned it over and hacked apart with his machete.

We carried the shell down the ountain and brought it back to the arwin Station. This specimen, in tter condition than the single shell om Pinta that the station already ssessed, was only the second fe-ale shell known to exist.

The last faint hope that remained as that Vagvolgyi's "small, not ry saddle-backed" tortoise could ll be found. Each time the wardens ent back to Pinta, they looked for but found no traces. They con-uded that it must have moved out the area; even if the tortoise itself caped their view, it surely would ve left some of the distinctive, gar-shaped droppings that abound tortoise country. But none were to found.

A year later, the promised copies Vagvolgyi's photos finally arrived. ey were good pictures, but tragic es; the tortoise was obviously the me adult male that had been taken the Darwin Station. Vagvolgyi ust have compared its size with that the huge tortoises of Alcedo or

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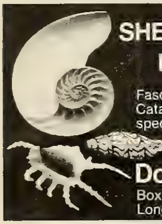

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Santa Cruz, and its degree of dorsal saddling with the Hood Island tortoises at the Darwin Station; by any standards other than these, it was a large tortoise and strikingly saddlebacked.

There is therefore little question that the Pinta tortoise now resident at the Darwin Research Station is the last of its kind; no further trace of tortoises has since been found by the wardens during their intensive goat-shooting expeditions to Pinta. At first, the tortoise was housed in a large, lava-walled enclosure between a group of Santa Cruz tortoises and the breeding colony of Hood Island tortoises. He was rarely seen, since with only a single tortoise to graze on them, the grasses and shrubs in the enclosure grew densely.

The last Pinta Island tortoise has since been promoted from solitary confinement. The Darwin Station has broken a rigid taboo, one which forbids the placing together of tortoises from different islands, and has placed two female tortoises of unknown (but not Pinta) origin in the enclosure with him. The purpose is to insure that he suffers no sexual dysfunction from inactivity, as is known to occur in some animal species. Ultimately, a mate will probably be selected from a neighboring population; that of Volcan Wolf on the northern end of Isabela Island is geographically the closest to Pinta, and since that subspecies is known for its extreme variability in shell shape, it should be possible to find a reasonable morphological facsimile of a female Pinta tortoise. There is of course no certainty that eggs from such a cross would be fertile (there is still debate as to whether the various, isolated Galápagos tortoise populations are subspecies or species), and there are other potential problems, such as the possibility that the female tortoise retained sperm from past matings in the wild (female chelonians of some species are able to lay fertile eggs years after male contact), but it is hard to suggest anything better.

Each time I have been to the Galápagos in recent years I have made a point of visiting this animal, but he hides under his shelter most of the time, and lurches back as fast as his skinny legs will carry him when dragged out for photographs. He may survive another year or even another century, but then, inevitably, the curtain will fall on the history of the tortoises of Pinta Island. □

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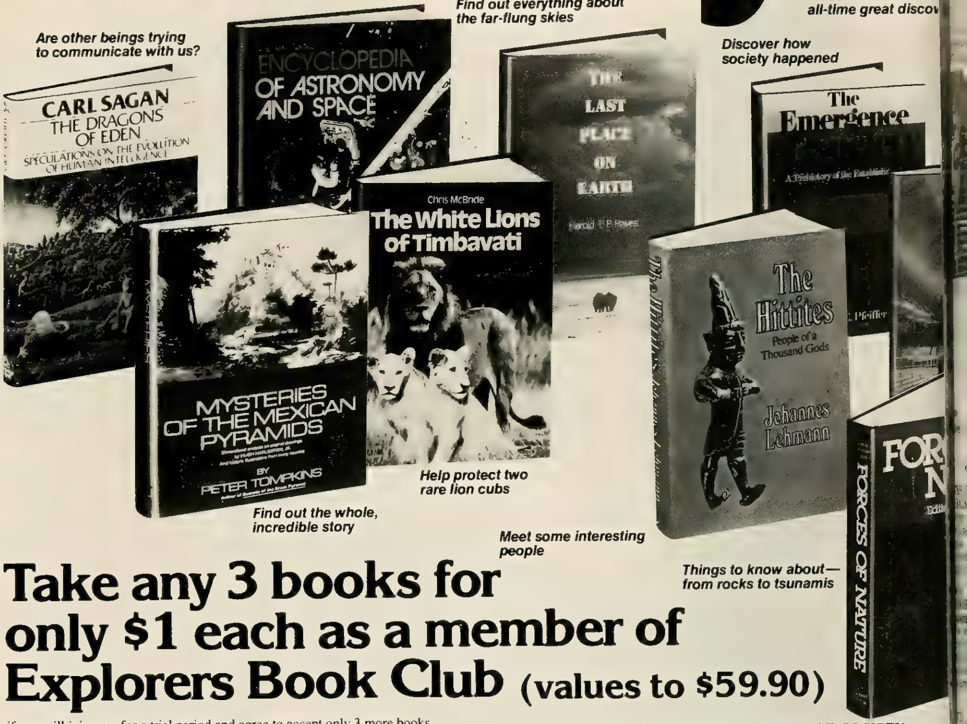
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Physics and the Cosmos

New theories devised by physicists make for interesting speculations about the early universe

Physicists and astronomers assume, as a working hypothesis, that the laws of nature that appear to apply here and now—on the earth in the year 1977—apply throughout the universe, have applied for all times past, and will apply throughout the infinite future. Stated boldly like this, such an assumption appears all but absurd — much too naïve. Indeed, it would be extremely exciting if that assumption could be shown to be wrong; if it were to turn out that new laws of nature do come into effect on the cosmic scale. So far there is no evidence for anything like this.

It should be noted that this idea—that the laws of nature are universal—is relatively recent in the history of science. The ancient Greeks, for example, were persuaded that celestial objects followed entirely different laws from those governing terrestrial ones. Planets, according to the Greeks, moved uniformly in perfect circles as befitted the perfect celestial "essence" of these objects. The word "quintessence" is derived from the idea of a fifth essence, to be sharply distinguished from the four local essences—earth, air, fire, and water. The change in attitude can be traced to Galileo, who discovered —with the then newly invented telescope—that there were spots on the sun and ''blemishes'' on the moon, indicating that these objects were not essentially different from the local commodities. However, the first scientist, to my knowledge, to present a truly ''universal'' theory was Newton.

According to Newton, gravitation was supposed to act universally, with the same force, among all objects in the universe. Despite the jokes made about it, I think that this is the real significance of the story (which seems to be true) about Newton and the falling apple. If an apple on a tree falls because of gravitation then one might imagine an incredibly extended tree reaching from the earth to all corners of the heavens, to the moon, the sun, and so on; and if one were Newton, one might speculate that these objects must also be falling under the influence of the earth's gravitational force. The moon would then be "falling" toward the earth, but fortunately, gravity is not the only force acting on it. The gravitational force is counterbalanced by a centrifugal force that keeps the moon up there, so we have nothing to worry about—from that quarter, anyway.

From our present point of view, the force of gravitation is the weakest force that we know about. If we take two protons, for example (a proton being the nucleus of the hydrogen atom), and let them interact with each other, the interaction will be influenced by other forces, all much stronger than the gravitational force. The strongest of these forces is the nuclear force, which at short distances causes the two protons to attract each other. Then there is the electric force, about a hundred times weaker than the nuclear force, which is responsible for chemical interactions and, in this case, repels the two protons mutually. In a large atomic nucleus there is a contest between these two forces, and the stability of many of these nuclei is a consequence of the fact that in this contest strong, attractive force wins. M atomic nuclei, however, are not ble, and this brings into play yet other force that physicists call weak force. The bulk of my rema will concern this force and some the new ideas about it. But firs would like to explain, very brie why, at least in our daily lives, gravitational force although the we est of all known forces, appears to the dominant role.

The explanation, fundamenta has to do with the universal chara of gravitation. Every mass in the verse attracts every other mass gr tationally. The attractions pile u bulk matter. A body such as the e is nearly electrically neutral— positive and negative charges all cancel each other out so the electr force does not play an important r for example, in determining pla tary motions. The nuclear force such a short range, it only comes play in the tiny atomic nuclei; he the gravitational force wins by fault.

As I have mentioned, many — fact, most — atomic nuclei are stable. They tend to break up spo neously. Some give off electr (negatively charged particles), so light quanta (particles of light), some break up into lighter nuclei s as the nucleus of the helium at These phenomena are known po larly as the radioactivity of nuc Each of these disintegrations is in esting to the physicist, but I wan concentrate only on those disinte tions, or decays, in which electron the smallest unit of matter that car an electrical charge—are produ These are called beta decays by physicists. The primal beta deca

by Jeremy Bernstein

ie decay of the neutron. The neutron : the electrically neutral counterpart f the proton in the atomic nucleus. . free neutron, outside a nucleus, is nstable. It breaks up spontaneously ito a proton, an electron, and a irious particle called the neutrino.

The discovery of the neutrino is orth some comment since it illusates how scientific thinking works. eta decays were first observed in eavy nuclei, and it was noticed that hen the electron emerged from iese objects it had varying energies. rom this observation physicists ould conclude, by using the laws of onservation of energy and momenim, that another particle also had to e emitted. (The Austrian physicist Volfgang Pauli made that suggestion the early 1930s.) But this particle as undetectable in experiments—it ould not be found. Nevertheless, iysicists insisted it had to be there. he first real theory of beta decay, eveloped in the early 1930s by nrico Fermi, included this object as necessary ingredient. The neutrino teracts so weakly with other matter at it was not until 1953 that the merican physicists Clyde L. owan, Jr., and Frederick Reines ere able to detect it directly in exeriments using nuclear reactors (in hich an incredible number of neuinos are produced). The neutrino, as r as we know, has no charge and no ass. But it is there.

The Fermi theory of beta decay orks very well provided one does ot question it too hard. When used compute very detailed answers, all ose answers, unfortunately, turn it to be infinite instead of finite. In at sense the theory is like a pinball achine that functions well, provided

(Please turn to page 112)

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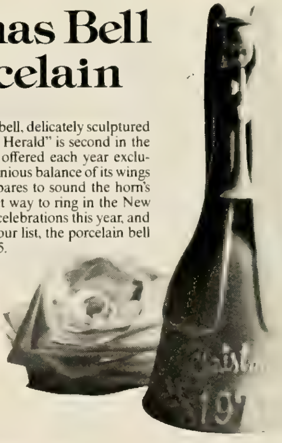

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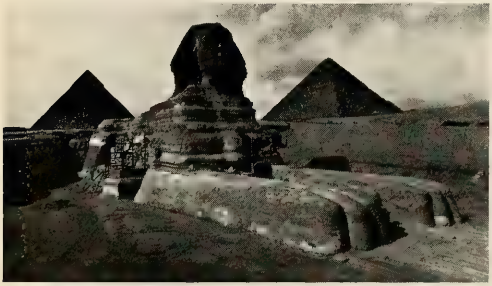

Construction details of the Pyramids and Sphinx have long intrigued investigators. Great Pyramid of Cheops, at right, is 755 feet long on each side, yet so well engineered that the Southwest corner is only ½-inch out of level with the Northwest corner.

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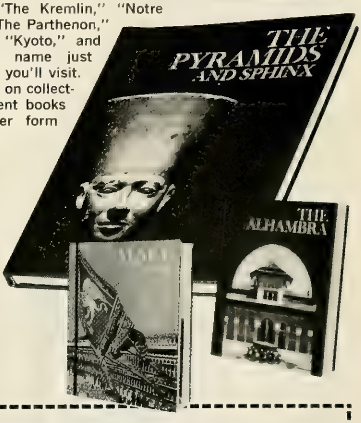

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one doesn't push it too much; when one does, it lights up "tilt." This was the situation in physics until some five years ago when an explosion of new theoretical ideas occurred, which has turned out to have consequences not only for beta decay but for the cosmos at large. I will try to give a flavor of these ideas, but in the interest of economy I will omit the names of the discoverers. (I am reminded of what Isaac Stern is supposed to have replied when asked to name the greatest violinist in the world. He responded that he preferred not to answer the question because "they are all my friends.")

For arcane reasons that will serve no purpose to go into here, the new theories are collectively called gauge theories. There is a class of such theories and they all have one thing in common: they predict the existence of new particles that have not yet been seen in the laboratory. One is not too disturbed by this since it took some twenty years before the neutrino was seen. The new particles are of various kinds. There may be new heavy electrons and new heavy neutrinos, and some preliminary evidence suggests that these objects, at least, are beginning to turn up in experiments done with the most powerful particle accelerators now available to physicists. In addition, the theories predict new mesons. The exact definition of what a meson is has changed over the years; at the moment, the term is used somewhat loosely to describe various sorts of objects. For our purpose it suffices to say that a meson is a particle that is not like an electron or a neutrino or a proton or a neutron. It is also not like a "quark," which, if it exists, would have a family resemblance to a proton or a neutron. In fact, in the modern view, the nucleus of the proton and neutron are thought to be made up of these hypothetical quarks.

Even before the explosion I referred to, physicists believed that such mesons must exist. Beta decay, for example, was seen as a two-step process in which the neutron, say, first decayed into one of these mesons, called the W particle by physicists—"W" standing for weak—and the W particle, in turn, decayed into an electron and a neutrino. These older W particles were electrically charged and very massive. In the new theories they are joined by electrically neutral counterparts that are thought to be even mo
massive. The fact that these objec
are so massive explains why the
have not been seen in accelerator e
periments. There is just not enoug
energy available in the present gene
ation of accelerators to produce then
New accelerators are now on tl
drawing board and when these a
constructed it is hoped that the W pa
ticles will be produced and detecte

There is, however, very strong i
direct evidence for the existence
these heavy neutral W particles. Tl
neutral W mesons can decay directl
into pairs of neutral neutrinos an
inversely, neutrinos can transfor
into each other by the emission of o
of these W mesons. This latt
process has been observed at the hug
accelerators in Geneva, Switzerlan
and at our own National Accelerat
Laboratory in Batavia, Illinois. O
servation of this process has give
physicists a good deal of confiden
in the whole scheme. I should al
point out that these new theories
not yield bad infinities so that t
"tilt" problem appears to have bee
resolved.

One of the most interesting aspec
of the new theories is what they ha
to say about astronomical and cosm
logical phenomena. First, a gener
philosophical observation, whi
takes me back to my introductory r
marks. All of these speculations a
based on the premise that our loc
science is really universal. No o
has been to a star, to say nothing
voyaging backward in time to the b
ginning of the universe. We do the
things in our minds and with instr
ments here on earth, and we marv
at the apparent coherence of the ente
prise.

As already noted, one of the cruci
features of the new theories is the i
teraction of neutrinos with neutro
and protons and, hence, with matt
in general, by means of a neutr
weak meson. According to tl
theories, these interactions can pi
up, much as the gravitational intera
tion adds up the effects of a vast nur
ber of different masses. A bundle
neutrinos coming into contact wi
heavy matter can produce a pressu
on this matter. This, it is conjecture
is an important mechanism for pr
ducing stellar supernova explosion
In this case, the heavy matter is t
iron nuclei in these stars and the ne
trinos are generated in the cooki
process that makes the stars radiate

e first place. Under the right cir-
mstances, these neutrinos can pro-
ce enough pressure to blow the
rs apart. Experts still disagree as to
w all of this works in detail, but the
ggested role of the neutrinos bears
ting.

Finally, these new theories make
iking predictions about the early
iverse. By now, most physicists
d astronomers appear to agree that
e universe began with a cosmic ex-
osion some 10,000 million to 20,-
0 million years ago. To review the
idence for this would require a sep-
ate essay, but it looks convincing,
least to me. The physics that ex-
ains the universe following the
ipse of the first one-hundredth of a
cond after the explosion is treated
rfectly well by the old Fermi theory
d other fairly simple general ideas.
it during the first one-hundredth of
second, the temperatures were so
gh — several million million de-
ees — and the particles were in such
ose contact with each other that the
uation resembled, in a general
y, what takes place in very high-
ergy collisions among particles
oduced in today's accelerators.
ie surprising thing about these col-
ions is that, as the energy gets
gher, they appear to be describable
simpler and simpler physics. This
n be explained, it turns out, by a
iture of the gauge theories that goes
der the fancy name of asymptotic
edom. In this domain, the particles
have, in some sense, as if they were
e of each other. Hence, at the tem-
ratures of the kind mentioned
ove, it is thought that the universe
nsisted of free quarks and mesons
t rattled around until the whole soup
oled off sufficiently to enable
oper nuclear particles to form. The
arks then got trapped inside the
ticles and some of the intricacy we
serve today was frozen in. The uni-
rse, it appears, has gotten more
nplex as it has aged.

It is clear that physics has come a
ig way since Newton watched an
ole fall in his garden but it is far
m clear where the voyage is lead-
. There are always surprises. That
one of the few things about this sort
science one can be sure of.

*emy Bernstein is professor of
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The most elegant midnight snack on :ord is the secret spread that Poryro prepares for his sleeping be-/ed, Madeline, in Keats's archaic :am tale, *The Eve of St. Agnes*. The nosel has gone to bed hungry, fol-ving the ancient custom that virgins o fast on St. Agnes Eve will dream their future husband. In this case, the l suitor comes by stealth to her bed-e, in "silver twilight," like a dream, l sets out a sweet table of exotic :am foods:

> . . . candied apple, quince, and plum, and gourd;
> With jellies soother than the creamy curd,
> And lucent syrops, tinct with cinnamon;
> Manna and dates, in argosy transferr'd
> From Fez; and spiced dainties, every one
> From silken Samarcand to cedar'd Lebanon

Like the stained glass in the windows Madeline's chamber, Porphyro's nu shines with rich colors and con-ıutes further to the hallucinatory feel the scene with its luxurious, sweet, ooth oriental fruits and spices. It is a al never seen before or after. Each n in it does, of course, actually exist he real world. Even manna occurs, ımiraculously, as a sweetish exudate he European ash, in flake form. And other glacé fruits and jellies crop up re or less often in our eating experi-e (although cinnamon-flavored up may occur only as an accidental, ldish experiment revolving around nch toast). But Porphyro's menu is lly only a symbol of sweetness, a taphorical match for the lovely Madeline. And even she doesn't eat it.

Nowadays, unlike the postfeudal era, with fresh fruit of some kind always available and sugar a commonplace, we have to summon a special imaginative effort to share Porphyro's delight at so cloying a collection of food. But, taken individually, glacé fruits still strike us as special. And dates, whose sweetness is natural, still seem a bit out of the way, like medieval sweetmeats.

Dates have never been absorbed into the mainstream of our diet. Despite a few fully naturalized date dishes — date-nut bread, date bars, and various date puddings — we only dabble in dates. While certain desert Arabs have been known to subsist almost exclusively on a combination of milk and dates, we have not advanced much beyond Madeline and Porphyro in normalizing our relations with the fruit of *Phoenix dactylifera*.

The first date palms were imported to the United States in tubs on shipboard from Egypt in 1890 and transplanted successfully at Salt River Valley, Arizona. Date palms travel well. It takes only a few years for a tree to grow from seed or sucker to maturity. Eventually, a mature plant may stretch up, nearly straight, a hundred feet, and it may easily produce more than one hundred pounds of the one- to three-inch-long berries with grooved seeds that we call dates. Since palms bear dates for as much as a century, it may still be possible to eat dates grown on the original American trees.

Date history goes much farther back, of course, beyond history itself, to some primordial date grove, probably in the Near East. There, cultivation is relatively simple, since the desert climate provides a temperature of 100°F or more. The only catch is that *P. dactylifera* is dioecious, that is, some trees bear male flowers; others bear females. As a result, hand-pollination is a necessity, according to standard sources, which do not explain why insect pollination apparently does not work with dates. Perhaps bees just don't like the taste of date pollen. At any rate, date growers must climb to dizzying heights on mature trees and tie the male inflorescence onto female flowers.

After successful pollination, two of the three ovaries on each female flower atrophy, while the third develops into a hard, green fruit, which eventually turns yellow or red and may remain hard or turn soft, depending on the variety. Fruits grow in clusters weighing twenty to forty pounds, which will ripen off the tree like bananas.

Fresh red or yellow dates are reportedly available in this country in Greek and other Levantine specialty markets, but I have never seen any, except in Moroccan souks. If you locate some, they can be boiled and then preserved in a sugar syrup. Along the Persian Gulf and in India, green dates are also boiled and then fried in oil or, it is said, pounded to a paste together with grasshoppers.

Commercial dates in this country are cured and dried. California produces in excess of twenty million tons a year. An additional fifteen to twenty million tons are imported. Connoisseurs assert that the best dates in the world grow in the Hasa district of eastern Arabia, where the waters of hot springs coax the fabled Khalasen variety to ripeness. The Middle East continues to be the leading date-growing area. By one estimate, the Basra district in Iraq has eight million date-bearing palms. Even in ancient times, the same region was so preeminent in date production that the Greeks called the date palm *phoenix*, the Phoenician tree. The date itself was called *daktylos*, which means "finger,"

ce, Photo Researchers

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1/3 cup brandy, 1/3 cup sherry, 4 tbsp. Grape Jelly
¼ lb. butter, 1 tbsp. Worcestershire sauce
4 duck breasts halved, skinned and deboned
2 tsp. cornstarch, 2 tbsp. water

Cook wild rice as usual. In covered skillet melt butter, stir in brandy, sherry, grape jelly and Worcestershire. Bring to boil, stirring to dissolve jelly. Add duck breasts. Cover. Reduce heat to low. Simmer ducks 20 minutes, turning once.

Place wild rice on serving platter; top with duck breasts; cover and keep warm. Blend cornstarch in water until smooth. Add brandy liquid to mixture placing in skillet. Stir and cook over low heat until thickened. Spoon sauce over duck breasts and wild rice. Serves 4, superbly! More recipes in every perfect pound of Minnehaha Wild Rice.

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as in *rhododaktylos*, or "rosy-fingered," Homer's epithet for the dawn.

While it is not difficult to see what was in Homer's mind, it is mystifying to try to reconstruct the original connection between dates and fingers in the Hellenic mind. Perhaps the Hebrew date-word *dekel* is a reflex of the original Semitic term that also led to *daktylos,* which is, of course, the source of our word "date."

Etymologies aside, the Middle East is still the place to look for sophisticated date recipes. Bedouins prepare rice pilaf with fried dates, almonds, and raisins. So do Armenians, who also grind up dates, dried figs, and almonds with sugar and cinnamon and roll the mixture into small confectionary balls. Syrians fill shortbread (*kleitcha*) rounds with boiled, chopped dates flavored with rosewater. They also make a date syrup (*dibis*) by squeezing blanched dates through muslin and then reducing the liquid by solar evaporation in large trays. This thick sweetener is then poured over tahini (sesame paste) or pieces of broken-up bread or ground walnuts.

If the sweetness of these dishes seems excessive to you, try another Middle Eastern dessert. Slice five bananas thinly and put them in a serving dish in alternating layers with a half pound of pitted dates. Pour 1¼ cups of light cream and chill overnight. The fruit absorbs the cream and acquires a smooth, rich texture.

Near Eastern Jews use dates for the traditional Passover dish haroset, instead of the apple used by other Jews in the Diaspora. They soak equal weights of chopped dates and raisins, in water to cover, overnight; then simmer them in the same water over low heat until the fruit turns into a thick paste. Flavor with red Passover wine and garnish with chopped walnuts.

If this still strikes you as too sweet, you might try stuffing a fish with dates, in the Moroccan manner. Moroccans also make a casserole of lamb chunks and dates.

Outside the Middle East, the date has inspired only a few outstanding culinary ideas. India leads the non-Arab countries in date dishes, with fried dates in cream garnished with unsalted pistachios and with a date cream composed of puréed dates (1 pound), clarified butter (1 cup), hot milk (1 cup), plumped raisins (¼ cup), slivered almonds (1 tablespoon), and toasted, unsalted pistachios (1 tablespoon).

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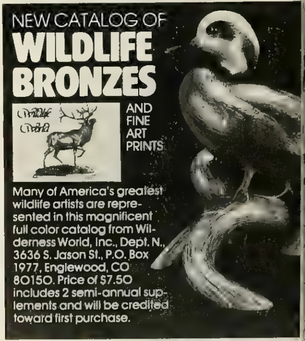

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inese desserts, eight-treasure rice *baofan*). They are one of the eight asures hidden in the glutinous rice of s legendary pudding. For more pro- c tastes, there is a superbly refined l light Brazilian date and peanut dding (see recipe below). Almost ry other nut, from walnuts to pe- ns, has been combined with dates in a dding somewhere. But for those who nk pudding is too heavy, date milk kes are a frothy California alterna- e. Alcoholic date drinks, from mild, mented "wine" to fiery, distilled, se-flavored arrack, round out the list date options.

You could, of course, dispense with king altogether and join millions, pping raw dates, the natural candy percent sugar as glucose or fruc- e, except for the semimoist Deglet or variety, which contains sucrose) your mouth, while repeating the rds of the prophet Muhammad: onor your maternal aunt, the palm, it was created from the clay left over r the creation of Adam (on whom be ce and the blessings of God)."

Brazilian Date Pudding

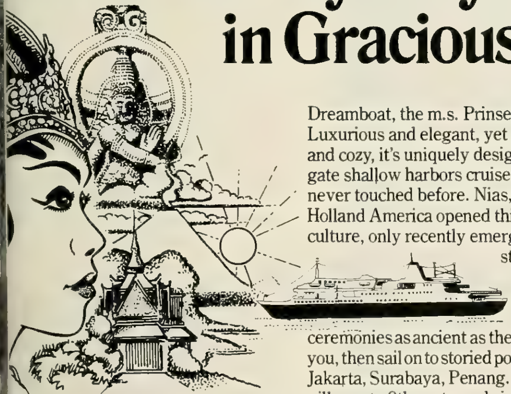
ised on a recipe of Ottilia Jansen de llo in Margarette de Andrade's *zilian Cookery*)

1½ cups sugar
½ cup shelled, unsalted peanuts
½ pound pitted dates
6 eggs, separated
½ cup milk
1 cup heavy cream, whipped
1 cup strawberries or raspberries

1. Line a 2-quart (8-cup) metal mold with caramelized sugar. (Tinned charlotte molds with little handles are ideal for this.) Put ¾ cup sugar and 3 tablespoons water in the mold. Heat directly over moderate heat until the sugar caramelizes. Plunge the mold for an instant into a pan of cold water and then tilt and rotate the mold so that the sugar flows evenly over the inner wall of the mold. You should be able to coat the entire interior of the mold before the sugar cools to a standstill. Invert the mold and set aside.
2. Preheat oven to 350°. Set a pan of hot water deep enough to come halfway up the mold (when the mold is immersed in it) on the middle level of the oven.
3. Combine remaining ¾ cup sugar with peanuts, dates, egg yolks, and milk in a blender. Purée. Then transfer to a mixing bowl.
4. Beat the egg whites until stiff but not dry.
5. Lighten the date–peanut mixture by stirring a cup or so of the beaten egg white into it. Then fold in the rest of the egg white.
6. Turn the pudding mixture into the prepared mold. Set the mold into the pan of water in the oven. Bake for 40 to 50 minutes, until a metal skewer will pierce the center of the pudding from top to bottom and come out clean. During baking, inspect the water around the pudding. Lower heat to 300° if it starts to simmer or boil. Also lower heat to 300° if the top of the pudding browns too quickly.
7. Let cool completely. Run a thin knife around the side of the pudding and invert onto a serving plate. Do not expect this surprisingly light dessert to hold its shape with the same glassy solidity you would get from a crème caramel.
8. Spread whipped cream over the top of the pudding and garnish the whipped cream with the berries.

Yield: 8 servings

Raymond Sokolov's most recent cookbook is The Saucier's Apprentice, *a guide to French sauces.*



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The Roots of Hunger

How the Other Half Dies, by Susan George. *Allanheld, Osmun & Co. (Universe Books, dist.), $12.50 hardcover, $4.95 paperback; 308 pp.*

Many would have us believe that world hunger is a regrettable but inescapable phenomenon caused by powerful forces over which we have little control. According to this view, the changing climate, the irreversible acceleration in the rate of population growth, and diminishing amounts of land on which to grow crops all make a solution unlikely. In this situation, the United States has a moral obligation to mitigate the misery by shipping its food and agricultural technology abroad.

That is one way of looking at the "problem" of 450 million malnourished human beings, but it is not Susan George's way. She places the blame on us—that is, on our inadequate human institutions, wrong priorities, bad planning, and nationalistic or corrupt government policies. The situation, she contends, did not just happen naturally. She quotes Bertolt Brecht: "Famines do not occur; they are organized by the grain trade." And she quarrels with the passive form of the statement we often read: "prices are rising." Somebody made them rise, she insists.

How the Other Half Dies is a polemical book, written from a strong personal point of view and steadily critical of the institutions that have failed so spectacularly to make any real dent on glo malnutrition in our time. But in ot respects it is optimistic. Once it is derstood that the problem is man-ma there is less reason for defeatis George gives short shrift to the not that climate and population gro have doomed the world to starvati She maintains that the problem is m ageable provided politicians and cor rate power structures can be forced do what is necessary to correct deficiencies in the system.

A few years ago many of these id would have seemed radical. But th years after the world food crisis 1974, analysts with no connection the politics of the Left have also be to question many of the old assu tions about hunger. No less a body t the august National Academy of ences concluded after extensive in tigations that producing more food not the answer to malnutrition. study that was conducted for Academy stressed that poverty and employment and inadequate distri tion systems are at the root of hun This summer, the United States ha thirty-million-ton stockpile of wl left over from the 1976 harvest beca nobody wanted to buy it. Yet malnu tion is severe in countries only a hundred miles away, such as Haiti Central America.

This is the dilemma that George vestigates. She does not say that sc tists should halt their research on p genetics, hybridization, photos by Dan Morgan

esis, cheap irrigation systems, and
:w systems of fertilizing crops. But
eorge insists that the real problems
e structural and political, not scien-
ic and technological.

Contrary to the popular myth about
e world running out of food, gov-
nments in wealthy countries often
omote and pursue a policy of
lanned scarcity" to keep the incomes
their farmers at "reasonable" (read
gh) levels. That is not true in the
ropean Common Market, where
vish price supports, subsidies, and
otective duties enable European
mers to produce wasteful surpluses
at seldom reach hungry people.
ut in the great wheat-growing coun-
es—the United States, Canada, and
ustralia — ninety million more tons
uld have been grown in the three
ars preceding the food crisis. The
vernments planned it that way. They
mpelled or provided incentives to
mers to idle vast acreages to prevent
erproduction. A few years later, in
summer of 1977, overproduction is
ain the number one problem of the
eat planners, and the stage is set for
w cutbacks in acreage and, eventu-
y, for another world food crisis.

In the United States, planning in ag-
ulture began in the era of the New
al when farmers were in a truly des-
ate predicament. As George points
:, there have been refinements in
nning techniques, but there is no in-
national system in place (and re-
rkably little political pressure to

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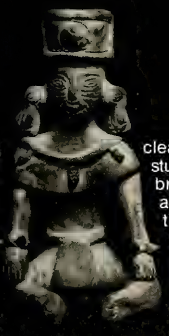

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create one) to prevent the ruinous cycle of "boom and bust" in the world wheat economy.

If the rich countries are part of the production problem, the developing nations are anything but blameless. It takes food grains such as wheat and rice to feed people, but in many countries vast acreages have been given over to growing cash crops that feed animals or people in distant, wealthy markets. Bananas, tea, cocoa, jute, tobacco, and groundnuts cover enormous tracts in countries where malnutrition levels are high. In the Philippines, 55 percent of the land is devoted to growing cash crops (mainly for export); in Mauritius, 85 percent.

The kind of crops being grown is not the only problem. Large landholders are still dominant in the land-tenure systems of numerous countries. Although they have the best access to bank loans, capital for buying new equipment, and information about modern agricultural techniques, they are inefficient producers of food, tending to invest as little money as possible in farming modernization.

Given the nature of the world hunger problem, there is something astonishing about the developments that have taken place in agricultural trade in the last thirty years. Whole farm economies have been reorganized to serve export markets, rather than to deal with the problem of malnutrition at home.

One of the worst pockets of malnutrition in the world is in northeastern Brazil. Yet the most dramatic agricultural story in Brazil involves the growth of soybean cultivation and the processing of soybeans into animal feed. Multinational agribusiness companies have invested heavily in the Brazilian "soybean miracle." The miracle has been good for the Brazilian economy and balance of payments. Brazil has become the world's second largest exporter of beans and of the processed meal that farmers in Europe feed to their poultry, hogs, and cattle. The multinationals are taking advantage of the worldwide need for rich sources of protein. But that need has little to do with feeding hungry people. It arises from revolutionary changes in people's diets all over the world. Europeans and Japanese now line up at fast-food emporiums to gobble hamburgers or enjoy Kentucky fried chicken. Broiler industries have grown rapidly in affluent western Europe since the early 1960s. It takes huge quantities of corn and soybeans to feed the livestock and poultry that are the basis of the fast-food trade.

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is development has been good for
ibusiness and good for the grain
le (which has doubled its interna-
ial food shipments since 1972). But
se dietary shifts have left virtually
ouched those segments of society
t lack money to buy food (let alone
e out at a fast-food restaurant) or that
out of reach of the food-distribution
works operated by traders and mer-
nts.

\s George notes, land used for *feijao*
ick beans) or for rice has been con-
ted to soybean cultivation in Brazil.
ıl estate prices of farmland suitable
growing soybeans have shot up, and
likelihood is that smaller, un-
hanized farmers will gradually be
ıinated by wealthier farmers who
afford to buy more and more land.
'he real planners of the radical shifts
lanting and eating have been com-
cial corporations. George asserts
the surplus capital of agribusiness
glomerates is a much more power-
force for setting agricultural
rities in countries than are govern-
t treasuries. In 1967, the chairman
ıe Bank of America had this pre-
ption for tackling world hunger:
e profit-oriented approach to in-
sing food production in the less de-
ped countries provides the only
hanism for real progress and deci-
action." A decade later, however,
e is nothing to suggest that agribus-
s has the fundamental answer to the
nnial problem of malnutrition.

'e resist the reality that food is just
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ıer and petroleum. Politicians and
orations, who have license to
r with the food-supply system,
ably have more to do with chang-
vheat prices than does drought.

ıe structural problems have been
avated by the well-meaning efforts
vealthy countries, she contends.
United States has given food aid
rously in years when its own
uses were large. But there is no
er any disagreement between ag-
tural economists that the massive
-aid shipments to south Asia,
a, Indonesia, and other places in
)60s had a not altogether beneficial
ct on indigenous farmers. The
ed States staved off famine in India
e 1960s, but probably created a false sense of security and discouraged Indian planners from investing more in agriculture. (Instead, India built up its armies and constructed an atomic bomb.)

George cites the green revolution as an example of flawed agricultural engineering on a global scale. She is hard on the Rockefeller and Ford philanthropic establishments for not seeing the drawbacks to new, high-yielding seeds developed in one place and superimposed on farmers elsewhere. The work on developing new seeds must proceed, but with much greater sensitivity to farmers' needs for easily adaptable hybrids. The results of the green revolution have been disappointing. In the inflationary spiral caused by the 1973–74 energy crisis, many farmers who had introduced new seeds on the assumption that they would have plenty of cheap fuel to run water pumps and cheap fertilizer to apply to the crops, were severely set back. It is interesting that China, which has roughly achieved food self-sufficiency, has not adopted any of the seeds developed at the International Rice Research Institute in the Philippines.

George treats very large, complicated subjects with a sprightly, provocative style. Her special contribution, and the reason the book deserves a wide audience, is that she forces us to discard simplistic notions about the hunger problem. She is opposed to "the brainwashing of innocent bystanders." Population is one subject that especially irks her. Populations explode for rational reasons since people have no incentive to reduce the number of their children. As long as wealth is badly distributed, the poorest segments of society will continue to raise large numbers of children as useful adjuncts to the family labor pool. The problem is not lack of food but lack of adequate social policies.

George calls her book a "plea for rationality and social justice." It is not a call that is likely to be enthusiastically heeded by politicians. Agriculture is perhaps the most sensitive political issue in the world today. World hunger cannot be ignored or explained away as a side-effect of population growth. Its existence is an indictment of modern civilization and a rebuke to us all.

Dan Morgan covers agriculture and the hunger problem for The Washington Post. *His book on multinational grain companies and the politics of food will be published by Viking Press next year.*

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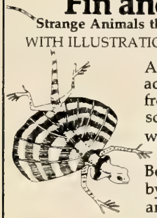

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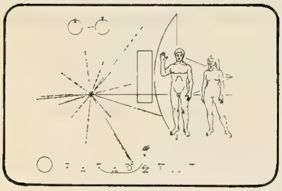

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Additional Reading

Andean Weaving (p. 48)

Peguche: A Study of Andean Indians, by Elsie Clews Parsons (Chicago: University of Chicago Press, 1945) is a detailed ethnography of the Otavalo Valley. This book is the result of Parsons's field work from 1940 to 1941 in Otavalo and in the neighboring town of Peguche. Another major study of the people of this region is *The Awakening Valley,* a richly illustrated black-and-white photographic essay on the Otavaleños by John Collier (author of *Visual Anthropology: Photography as a Research Method)* and a local ethnographer, Anibal Buitron (Chicago: University of Chicago Press, 1949).

There is an excellent chapter, "Weavers of Otavalo," by Frank Salomon, in *Peoples and Cultures of Native South America,* edited by Daniel R. Gross (New York: Doubleday & Co./Natural History Press, 1973, $5.95 in paperback), which gives a concise summary of ethnographic knowledge to date. This book also contains an extensive bibliography on the greater subject of South American Indians.

The Auroras (p. 60)

Thomas A. Potemra's article, "Aurora Borealis: The Greatest Light Show on Earth" (*Smithsonian,* February 1977, pp. 64–70) is a popular treatment of the subject of upper atmosphere electrical currents. A journal article, "Recent Progress in Studies of DMSP Auroral Photographs," by S. I. Akasofu (*Space Science Reviews,* 1976, vol. 19, pp. 169–215), interprets satellite photographs of the aurora borealis. It is illustrated with photographs and schematic diagrams. *The International Auroral Atlas,* published for the International Union of Geodesy and Geophysics by Edinburgh University Press in 1963,
provides another way of looking at
aurora — through colored sketche
the aurora's curtainlike structures.

More detailed are three works
will either satisfy readers' curiosit
send them to other sources by wa
bibliographies. *Physics of the Au*
and Airglow, by J. W. Chamber
(New York: Academic Press, 1961)
classic source for description and
planation. More recent and most c
prehensive is A. Vallance Jones's
Aurora (available in paperback fro
Reidel Publishing Co., Hingh
Maine, for $24.00), which include
up-to-date bibliography as well as s
lite photographs. *Keoeeit; The Sto*
the Aurora Borealis, by William Pe
published in 1963 by Pergamon P
New York, introduces Eskimo
Scandinavian mythologies that
evolved around the aurora since
first set eyes on it.

Monk Seals (p. 78)

Two sources provide basic info
tion about the Caribbean monk
Victor B. Scheffer's *Seals, Sea*
and Walruses: A Review of the
nipedia (Stanford: Stanford Unive
Press, 1958) and *Mammals o*
World, third edition, edited by Ern
Walker, et al. (Baltimore: Johns
kins Press, 1975). A 1964 bibliogr
from the second edition's volume
monk seal sources on page 430.
most authoritative work on the bi
of the monk seal is "The Monk Se
by Judith E. King, *Bulletin of the*
ish Museum (Natural History),
ogy, 1956, vol. 3, no. 5.

Documented Caribbean monk
sightings since the time of Christ
Columbus appear in *Extinct and V*
ing Mammals of the Western
sphere with the Marine Species of

eans, by Glover M. Allen (*Special plication No. 11* of the American mmittee for International Wildlife tection, 1942), and Remington Kelg's "Past and Present Status of the rine Mammals of South America the West Indies," on pages 299 to of the 1942 *Annual Report of the thsonian Institution.* The *Red Data ok* of the International Union for the nservation of Nature is a loose-leaf npendium of periodically updated letins on rare and endangered spe-. Each information sheet includes a iography for the animal in question; Caribbean monk seal is sheet nber 13.111.11.2 in the mammals ume.

eneration (p. 84)
general, accessible treatment of subject of tissue regeneration in nals is Richard J. Goss's *Principles egeneration* (New York: Academic ss, 1969). Goss includes a great deal lustration and gives bibliographical tions. A more technical review of subject is *Loss and Restoration of enerative Capacity in Tissues and ans of Animals,* by L. V. Polezhaev mbridge: Harvard University s, 1972). Marcus Singer's *Limb neration in the Vertebrates* (Read- Addison-Wesley Publishing Co., ; an Addison-Wesley Module in ogy, No. 6) focuses primarily on es and their role in the actual mechn of regeneration. Singer has also en a useful summary, "The Reration of Body Parts" in *Scientific rican* (October 1958, pp. 79–88). e specific material on electrical rols and their role in the regenera- process is found in "Electrical rols of Development," by Lionel ffe and Richard Nuccitelli (*Annual Review of Biophysics and Bioengineering,* 1977, vol. 6, pp. 445–76), and in "Effects of Electrical Fields upon Regeneration in the Metazoa," by Stephen D. Smith (*American Zoologist,* 1970, vol. 10, pp. 133–40).

Pinta Island Tortoise (p. 90)
Ian Thornton's *Darwin's Islands: A Natural History of the Galápagos* (New York: Doubleday & Co./Natural History Press, 1971, $8.95) provides general background about the giant tortoise's range. Another general treatment is Peter Pritchard's *Living Turtles of the World* (Neptune: TFH Publications, 1966).

Craig MacFarland, director of the Charles Darwin Research Station in the Galápagos, and José Villa and Basilio Toro of the Ecuadorean Park Service, have written two status reports on the Galápagos giant tortoise for 1974 issues of *Biological Conservation.* Part I, "Status of the Surviving Populations," appears in volume 6, pages 118–33 and Part II, "Conservation Methods," is in volume 6, pages 198–212.

In 1964, the Galápagos International Scientific Project, an expedition of more than fifty scientists, descended on the islands in helicopters. An issue of *Pacific Discovery* (vol. 18, no. 5) is dedicated to reports from the expedition and the opening of the Darwin Research Station. Particularly interesting is John R. Hendrickson's "Reptiles of the Galápagos" (pp. 28–36), with good black-and-white photographs and a bibliography on page 37.

For Joseph Vagvolgyi's pictures and account of his locating the last Pinta tortoise consult his 1974 article in *Pacific Discovery,* "Pinta Tortoise: Rediscovered" (vol. 27, no. 2, pp. 21-23).

Pamela Haas

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Celestial Events

Thomas D. Nicholson

Sun and Moon The sun is in the constellation Virgo until the end of October, moving into Libra in November. During this part of its easterly path through the stars, it drifts rapidly southward, shortening the days and lengthening the nights, lowering the diurnal path it follows from sunrise to sunset. It moves past Spica, in Virgo, about October 17. But on October 12, it keeps a date with the new moon to produce a solar eclipse (see below).

The moon is a morning object in early October, rising late at night and remaining in the morning sky. It is at last-quarter phase on the 5th, and new moon occurs on the 12th. By the 15th or 16th, you will see the early crescent moon in the western sky just after sundown. Thereafter it will come into view higher and fatter each night and remain in the sky longer. First-quarter moon is on October 19, and full moon (the hunter's moon) is on October 26. A morning object again in early November, last-quarter is on November 3, new moon on November 11.

Stars and Planets Mercury is the only naked eye planet in the evening sky in October. It moves to the east (left) of the sun on the 18th and remains an evening star (but poorly placed for viewing) through November. The other four planets are morning stars, generally quite bright and well situated for viewing.

Jupiter and Mars rise before midnight and are quite high in the south in the dawn sky. Both are in Gemini. Jupiter, the brighter of the two, is well to the west (right) of the twin stars Pollux and Castor. Mars (to the left of Jupiter) moves into line with Pollux and Castor on October 16 and then moves away to the east. Saturn and Venus rise well after midnight. In the dawn sky, Venus — the brightest object you will see, except when the moon is present — is lower in the east. Saturn is in Leo, higher and to the right, and near the bright star Regulus.

October 4-5: The waning gibbous moon moves past Jupiter and Mars in the morning sky.

October 8-10: The morning moon is now moving past Saturn and Venus— closer to Saturn on the 8th and 9th, to Venus on the 10th.

October 12: There will be a solar eclipse today, visible from much of the North Pacific Ocean, most of North America, and part of South America. A total eclipse will occur in a narrow path of the Pacific and in northern South America. In North America, the eclipse will be partial, occurring shortly after noon along the west coast, in late afternoon along the east coast. It will last about two hours.

October 15: The moon is nearest earth (perigee).

October 18: Mercury, in line with, but beyond, the sun, enters the evening sky.

October 21: The Orionid meteor shower reaches maximum. An observer may expect to see up to 25 shower meteors per hour after midnight, some quite bright.

October 24: Jupiter, approaching opposition from the sun, becomes stationary with respect to the stars and begins to move westward (away from Gemini, back toward Taurus).

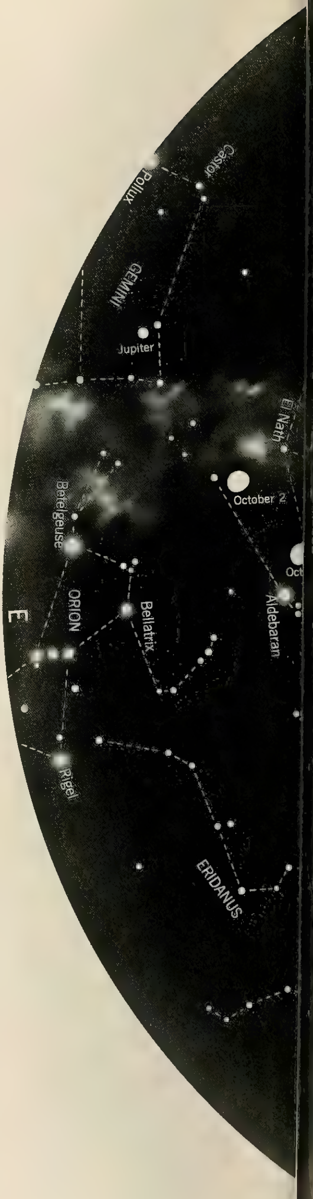
October 31: The moon is farthest from earth (apogee).

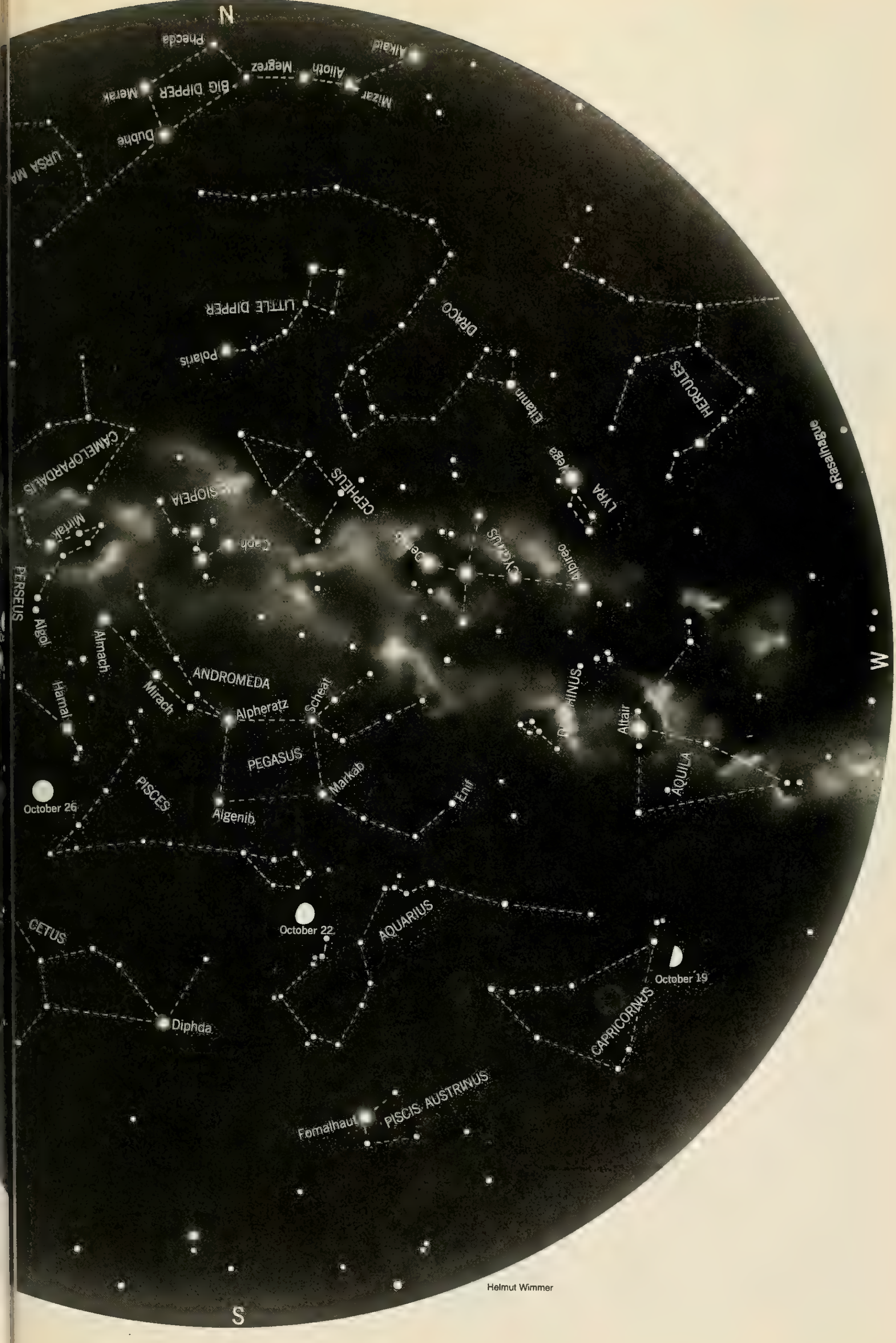
November 3: Saturn has been approaching Regulus in Leo. Today it passes the star and moves away to the east. The bright object near the moon is Mars.

November 4: The relatively weak (15 per hour) and dim Taurid meteors reach maximum.

November 5-6: The object near the moon is Saturn.

★Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:15 P.M. on October 1; 10:20 P.M. on October 15; 9:10 P.M. on October 31; and 8:15 P.M. on November 15; but it can also be used for an hour before and after those times.

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CETUS
October 22
AQUARIUS
October 19
CAPRICORNUS
Diphda
PISCIS AUSTRINUS
Fomalhaut
S

Helmut Wimmer

Eskimo Tales

by Dorothy Harley Eber

Arctic authors are subject to the same literary jealousies as their southern colleagues

At least once a year a writer can count on reading a newspaper column or magazine article on the notable nastiness of writers, not necessarily toward each other but toward each other's books. During the past two or three years, the literary section of the Sunday *New York Times* and the Canadian magazine *Saturday Night* have carried such items. It is a perennial theme, but just how ubiquitous, I learned in the Canadian Arctic.

For part of the past six summers I have been interviewing elderly Eskimo living in Cape Dorset on Baffin Island, taping their reminiscences in order to write oral histories of their traditions. I quickly learned that passions rage on the Hudson Strait as violently as in warmer climates. Just the same it was a surprise to discover that a literary reputation can be badmouthed in the Arctic as thoroughly as if the locale were New York.

The first clue came from Echaluk, an elderly widow, who popped out of her prefab one day in front of my interpreter and me, as we trudged along with our tapes, recorder, and other paraphernalia, and announced, "Pitseolak never caught a goose."

This was abrupt, but I recognized the reference to the goose. It concerned a passage in the book that Pitseolak and I had recently published. I replied mildly, "Oh, really. She says she did." But afterward, when I analyzed Echaluk's remark, I realized it was loaded—an attack on my collaborator's credibility. Echaluk was really saying that Pitseolak had exaggerated her age (upward; old age in the Arctic is something to be proud of) and therefore in the early days of the century when the Eskimo had very few guns, Pitseolak was just a baby and unlikely to have been a good witness to the old-style goose hunts she described:

> Four people would corner a goose and my parents would tell me to run up behind it hooting and shouting and put my foot on its neck. I'd run and I'd catch the goose and I'd stand there waving my arms like a bird. Sometimes we'd all have headaches from shouting and yelling.

On my first summer visit to Cape Dorset, Pitseolak, a disarming personality and a remarkable graphic artist, had given me wonderful glimpses of "the old way." She had a gift for homey detail that made life in the now vanished igloos and skin tents vividly real—and somehow familiar. In daily interviews, she talked about how to sew kayaks, the games she played as a child, the problems of a wealthy hunter with four wives: "Sometimes it would get quite dark and that poor man would still be building the igloos!"

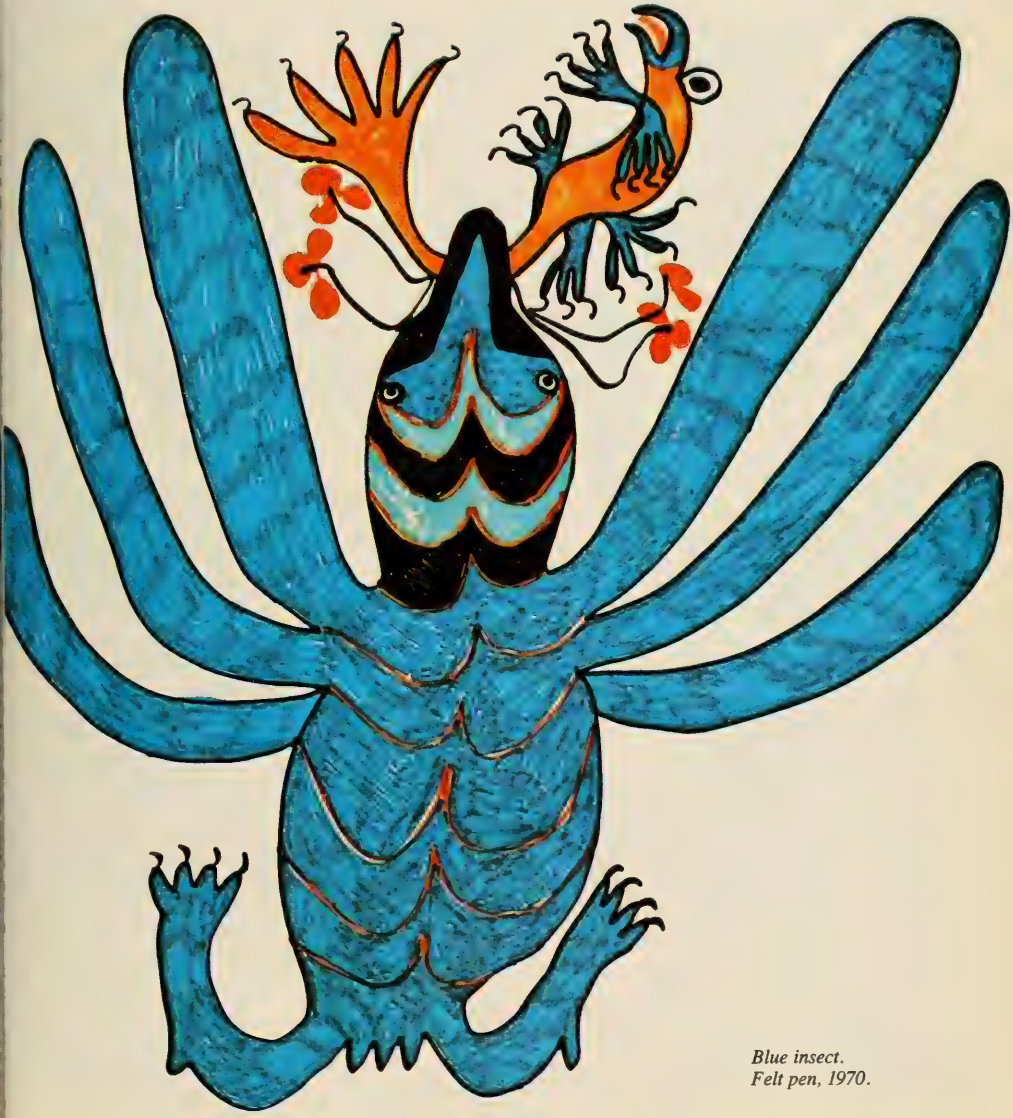
Pitseolak's willingness to answer hundreds of questions with great good temper and often considerable passion meant the work on her oral biography went easily and was always highly rewarding. Still, our collaboration had its unusual aspects. I had explained that people in the south (Montreal) thought she and I could put together a book, but one day—just before I packed to go home—my interpreter said, "Pitseolak wants to know what you are going to do with all this material?" Pitseolak was familiar with the Bible and with her grandchildren's school books but there all reading matter stopped.

What were books for? Our young interpreter did her best. "People in
the south spend all their time rea
ing!" Pitseolak knew this was no
sense. Her reply was immedia
"When do they eat?" But eventua
our book, illustrated by Pitseola
and in an Eskimo-English biling
edition, was published, and Pitseol
made her first trip down from the A
tic to stay at the Montreal Ritz a
guest of the publisher. ("How do y
like it here?" "I feel very much
home, thank you.") During her vi
she ate in restaurants, moved ab
on escalators, handled the press w
aplomb, and seemingly was up
only once by the mysteries of the
erary world. When the publis
showed her around his warehou
she worried that she would have
sign all the books.

When Pitseolak got back to C
Dorset, the Hudson's Bay post
copies of our book. By the time I
rived the next summer and settled i
interviewing other elderly Do
people who had distinguished the
selves in the graphic arts, residents
the community were familiar with
contents—and not slow with th
comments. Not only had Pitseo
added several years to her age;
was also guilty of unseemly boast
about her lifestyle in the old da
"Pitseolak's husband was ne
rich—he never had eight dog
"Pitseolak's husband's igloos—
couldn't even *get into* her husban
igloos." And there were rema
with a nasty personal ring: "
standards of housekeeping in
family were never very high."

The matter of the goose was
tainly a sore point. The widow Ec
luk, reportedly once a hunter with
own team, was a person who ha
be taken seriously. "If Pitseolak
caught a goose," she declared,
was a very small goose." Etid

Illustrations from *Pitseolak: Pictures out of my life,*
University of Washington Press



Blue insect.
Felt pen, 1970.

and his son Udjualuk—who sometimes came with me on interviews to interpret—went out on the tundra and tried to catch geese in the way Pitseolak described. They reported they couldn't run fast enough to catch a goose free on the grass. You had to have stone pens. Obviously, Pitseolak didn't know what she was talking about. She had been too young to really know about the old ways. "She should have said she didn't know about these things when she was questioned," one critic informed me.

Despite this critical reaction, the book had not hindered my chances of getting further interviews. I am often asked, "Aren't the people afraid to talk to you when they know everything is being recorded?" But this particular summer, this did not seem to be the case. People I interviewed often seemed quite relieved when they realized I had done with chitchatting and turned on the tape recorder. Some who had tape recorders of their own would help me tune the levels and would pause and gesture meaningfully when the tape ran out. Many of the old people I talked to believed that the old stories should not be forgotten. Books were a good idea, they seemed to feel, even if Pitseolak's venture into print was stirring up a storm.

At first I worried about Pitseolak's feelings. On one visit I gingerly brought up the matter of the goose. Pitseolak insisted she had caught, not one, but two geese on the grass. (I did not ask her if they were very small geese.) She also told me more about her journeys in the umiaks—the huge skin boats with sails made from intestine—which, although seen in the Cape Dorset area until the Hudson's Bay Company arrived in 1913, had also been disputed. She remembered sitting in her mother's *amoutik,* or *amaut* (a special pouch in a woman's parka), and playing with her mother's braids as they traveled in the great boats. Once there was an accident, and her mother, who was pregnant, fell over in the umiak and miscarried. On the whole, Pitseolak appeared unconcerned although she knew she had critics. "Pitseolak does not tell lies although some people say she does," she remarked. Perhaps Pitseolak felt that publication was worth the criticism and difficulties it frequently brings. Royalty checks arrived occasionally; the Royal Canadian Academy of Arts made her an academician (she showed me the diploma and explained, "I got it for being a *good* artist"); a large corporation asked her to make a drawing for an advertisement; more people wanted to buy her beautiful "old way" pictures (the Smithsonian Institution is currently circulating an exhibition of her drawings); new sources of income opened up. The interpreter remarked one day, "Pitseolak says she is really grateful she was able to buy that small refrigerator. She has it beside her bed and now she can get good cold water whenever she wants."

Another charge I frequently heard was that Pitseolak had not told "all." She had not, for instance, mentioned a relationship with the Bay Company man in Cape Dorset. To this I generally replied, as pointedly as possible, that few of us would want to reveal all. But to tell the truth I have never been really interested in the Bay man although I have always loved to hear Pitseolak talk about her husband, Ashoona, who died too soon. Whenever we meet nowadays his name generally comes up:

> When Ashoona came to the camp I didn't know why he came. I didn't know he came for me. I thought he'd just come for a visit—until he started to take me to the sled. I got scared. I was crying and Ashoona was pushing and sometimes picking me up to try to put me on the *komatik* ["sleigh"]. Anyone trying to get married would often have to carry the girl! At that time the young girls used to be really afraid of the men—frightened to go to bed with them. The first time I was sleeping beside my husband his breath was so heavy, his skin so hard. But after I got used to my husband I was really happy; we had a good life together. The first time we went to Netsilik [a large, distant lake] we were all alone for a year and Ashoona delivered my son Kumwartok. With my mother to help. When my husband died at Netsilik even though I had relatives, it was as if my whole family had died—I had no one anymore. Ottochie, my youngest son, was in the *amoutik.* He was the only one who didn't learn how to hunt from his father. Ashoona taught his sons to hunt before he died. After Ashoona died at Netsilik, when the geese were coming south and flying overhead down here past Cape Dorset, I used to think, "These geese have been with Ashoona back in Netsilik. They've been at Ashoona's grave." When it was really dark and I could hear the geese overhead, I'd go outside and I'd yell, "Goodbye, goodbye!"

The most vocal of the critics was another Pitseolak, although no relation—Peter Pitseolak, a former camp boss generally regarded as the region's official scribe. The name Pitseolak, which means "sea pigeon,
is a popular one in south Baffin Is
land. A most remarkable man, Pete
Pitseolak was an accomplished pho
tographer and considered it a failin
that his people had become literat
only at the turn of the century. "W
were stupid; we should have though
of writing on sealskins!" For years h
had kept—in neat syllabics (the sys
tem of writing the missionarie
brought)—notes on births, deaths
and important happenings in th
camps. There was more, much more
Peter Pitseolak suggested, that coul
be better told. "Don't believe every
thing some other Pitseolak tel
you," he warned.

Months later when I was back i
Montreal, the post delivered a lon
mailing tube. Out of it came pag
after page of syllabic manuscript -
Peter Pitseolak's own story, ar
as far as I know, the only written aut
biography of any length by a
eastern Arctic Eskimo of his genera
tion. Shortly, with a grant from th
Canada Council's Explorations Pr
gram, I returned to Baffin Island
interpolate the written material wi
oral biography. It was a memorab
experience. Peter Pitseolak did i
deed have much to tell and was eag
to tell it; he had a powerful mind ar
a great storehouse of knowledge. Th
interviews with Peter Pitseolak we
a joy to do—and as stimulating,
think, for the interpreters as for me

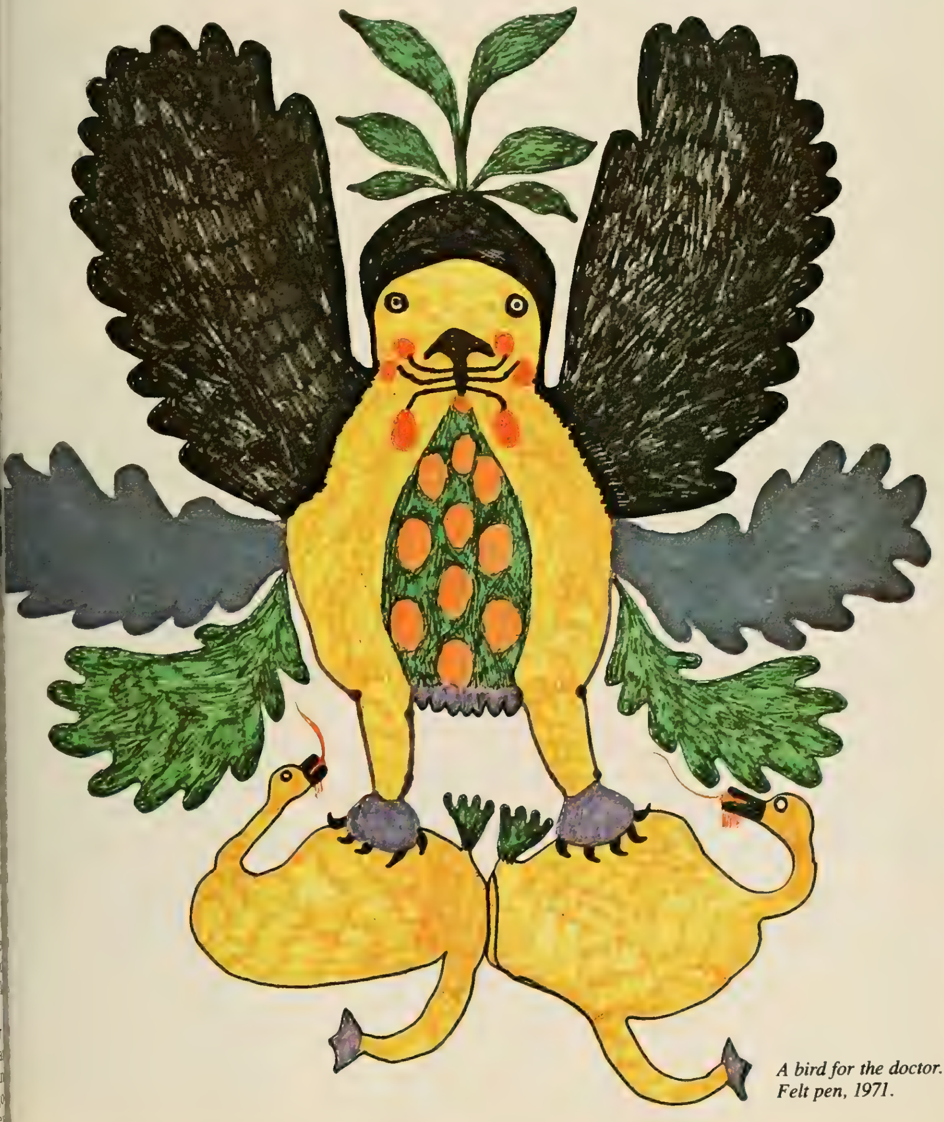
But as we worked, I detected son
background static. Eleeshushe
Peter Pitseolak's half-sister, into h
eighties and perhaps ten years his s
nior, was gravely suspicious of th
stories her younger brother was pas
ing along and also felt the method
which Peter Pitseolak had obtain
some of his material confirmed a bl
on his character. "He was always
lazy boy," she remarked. "He w
always in bed. When the adults we
talking on the sleeping platform in t
igloo he would sit there. Though
might appear not to be listening,
was listening all the time." And
the day I finished checking the tap
and packed my bags and walked
to the airstrip, I again encountered t
formidable widow Echaluk. "Pe
Pitseolak does not remember as mu
as he thinks he does," she remark
darkly.

I was forewarned; still, a letter
ceived in Montreal, just as the mar
script on which Peter Pitseolak an
had collaborated was ready to go
the printer, brought startling nev

e work was accomplished in the
k of time—he died four months
r we finished the interviews.) A
ural committee of three elders had
n formed in Cape Dorset, and be-
se the members felt Peter Pitseo-
might remember things dif-
ntly from how they actually were,
would be willing to help by
cking the manuscript. Of course I
appalled. The desire to censor is
arently strong in man. But not
rly so strong, work in Cape Dorset
vinces me, as man's desire to communicate. After some thought, I wrote back, paraphrasing words attributed to Harry Truman: Clever men can never agree.

Now I am awaiting results. Hasn't the competitive notion that there is a story to tell more honest, more beautiful, more deserving of respect than the tale told by a rival sent many a chronicler to the typewriter? It is my hope that the three members of the cultural committee, finding themselves in strident disagreement with the published reminiscences of the two Pitseolaks—and, I think I can safely predict, with each other—will set down their own versions of events. If they do, and three separate syllabic manuscripts result, those cultural committee members will merely have become part of the same literary tradition as their colleagues south of the Arctic.

Dorothy Harley Eber is a Canadian journalist who has produced two oral biographies, Pictures Out of My Life *and* People From Our Side.



A bird for the doctor. Felt pen, 1971.

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nnouncements

eru's **Golden Treasures,** an exhibit
nore than 200 gold pieces spanning
00 years of Peru's largely unknown
ory, will be on display in Gallery 77
n October 5 through December. In-
led will be such delicately wrought
ects as a minutely detailed pair of
len gloves from the Chimu culture;
backrest of a litter, magnificently
orated with small gold figures; a
chica pectoral in the shape of a new
on with monkeys playing along its
er edges; and numerous masks,
uettes, and vessels. The artifacts are
of the collection of the Museo Oro
Peru in Lima. The collection was
un in the 1930s by Miguel Mujica
lo, a Peruvian concerned that much
is country's golden heritage was
ppearing at the hands of robbers,
looted tombs of offerings to the
l placed in them thousands of years
The exhibit will also include ar-
ts from the American Museum's
Peruvian collection. There will be
ored examples of Paracas mantles,
which were used to wrap mummies, as well as displays of clothing, pottery, shells, and musical instruments, all discovered in tombs of Peru's various ancient societies.

Beginning in October, the Education Department will sponsor six series of unlimited enrollment **Evening Lectures**: Archeology of Ancient Egypt; Magic and Witchcraft; Social Behavior of Animals; The World of Birds; Wildflowers of the North; and Insects: Earth's Most Successful Animals. Each series will be presented either by members of the Museum's scientific staff or by experts from other museums or universities. The cost ranges from $20 to $35 for individual series. For information about length of each series and registration call (212) 873-7507.

On October 13, the Museum Membership Office will present a program devoted to **The Bowhead Whale: Monarch of the Seas.** The event will include a screening of *In Search of the Bowhead Whale* and a discussion by Scott McVay of the Environmental Defense Fund. In 1973, McVay led an expedition to the Bering Sea to study and photograph the behavior of this rare whale, and record its sounds. An offshoot of the expedition was the filming of the bowhead's spring migration along the northwest coast of Alaska from Point Hope to Point Barrow.

The bowhead used to be so numerous in the Arctic Ocean that it was commonly referred to as "the whale." For 300 years, the species—the only baleen whale that lives year-round in the Arctic—was ceaselessly hunted by Europeans for its oil. Now, only a handful remain in the Bering, Beaufort, and Chukchi seas off Alaska and Siberia. These are hunted only by Eskimo, who rely on the bowhead's meat, blubber, and bones for subsistence.

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Letters

Lightning Strikes Again

Richard E. Orville's otherwise excellent article "Bolts from the Blue" (June/July 1977) had one major flaw. He states, "the charge delivered to the earth's surface in a lightning flash is only about 20 coulombs, enough to operate one 100-watt bulb for just over 20 seconds." Horsefeathers! The one coulomb per second (one ampere, to those who find amperes more comfortable) is for current supplied across a voltage drop of 110 volts. The energy is given by the product of charge and voltage: thus a 100-million-volt discharge of 20 coulombs supplies 2,000,000,000 joules—enough to keep a 100-watt (110 joules per second) bulb burning for 20 million seconds or more than 5,500 hours, or about 231½ days. In other words, each lightning flash supplies more than 555 kilowatt-hours. If it were possible to tap this source of energy, it would be quite useful, and not merely a laboratory curiosity.

MARK E. KAMINSKY
Trinity University
San Antonio, Texas

THE AUTHOR REPLIES: The above calculations are correct. Unfortunately, virtually all this energy is dissipated into heat, light, and thunder in the atmosphere and is not available for use at the ground. But let us ignore this loss and assume, as Mr. Kaminsky has, that 555 kilowatt-hours are available and can be tapped as a source of energy.

How many lightning flashes are needed to meet the electrical requirements of a home? My four-bedroom house used 900 kilowatt-hours in a recent month and would therefore need the energy from twenty lightning flashes to meet my yearly electrical needs. A typical flash density in our area for thirty thunderstorm days per year is about ten flashes per square mile per year. So if I collected all the energy from lightning flashes to ground in two square miles the electrical energy needs of my home would be satisfied.

If this seems impractical, I could meet a fraction of my electrical needs by erecting a 325-foot tower near my home and using the electrical energy from lightning striking the tower. Research indicates that most lightning within a 650-foot radius of the tower would hit it, and that this would amount to at most one strike per year. This would supply, according to our assumptions, 555 kilowatt-hours or a continuous power supply of 55 watts. Of course the available power will be much less since in all our calculations no account has been taken of the energy losses in the lightning channel and of the inevitable losses in the storage area. It would appear that lightning as a practical energy source is not useful and will, in fact, remain a laboratory curiosity.

The Grizzly Grapple

I read Christopher Cauble's article, "The Great Grizzly Grapple" (August/September 1977), early this morning and, in a rare burst of intellectual energy, would like to make a comment. The killing of Stony Bear, purely and simply because she might have cubs and then might become overly protective, is certainly an act that should not have been carried out. No one in my family has ever been mauled or killed by a bear, so I presume I am somewhat biased in favor of bears; but following this line of reasoning in regards to the human race brings up so many possibilities that it boggles the mind.

GARTH E. FORT, M.D.
Nashville, Tennessee

Mr. Cauble gave a fairly unbiased report on the situation concerning the grizzly bear in our National Parks; that is, until the last paragraph of the article. His statements are a bit extreme and will probably not be met with enthusiasm from the nonbiologist segment of our society.

The offensive segment of his last paragraph is: ". . . if we can yawn and accept the reports of tens of thousands of deaths from automobile accidents and mishaps in the home, can we not tolerate the exceedingly rare death due to a grizzly bear?" We found this sentence offensive because of its inaccuracy. People aren't taking highway accidents lightly; as shown by safer highway design, traffic laws, and enforcement. People aren't outlawing highways because of traffic accidents, and they aren't just sitting back a letting them occur.

Let us close with comment. No! M Cauble, the public will not just yaw and allow their children or themselv be mauled and killed by grizzlies, more than they will tolerate car ac dents. We personally have confiden that an acceptable solution to th problem will be found.

JACK and ROSALIE SEIM
Campbell, Californ

I was not very pleased with the ar cle, "The Great Grizzly Grapple," t did appreciate the author's effort bring a matter this serious to the atte tion of the public.

I was both outraged and appalled what the National Park Service h been doing over the years to the grizz and very much concerned about t public's reaction to the plight of t animal.

Considering that the ratio—appr imately three out of every 1,600,0 persons visiting the Glacier area attacked by bears—of bear/people cidents is extremely low, I think odds favor the public. As was poin out in the article, the public seems i mune to deaths caused by motor hicles. I fail to understand the outrag a grizzly who attacked someone wh that animal has probably been bothe to death by people in his home— parks. These are not tame animals should they ever become so. But peo fail to understand nature and feel th have to tame everything as long a falls into their controlling patterns man can't control it—he doesn't wa around. I find this quite sad and mensely frightening for all of us.

Mr. Cauble wrote that the grizzly been hunted for years in the Bob M shall Wilderness Area, and that th bears don't seem to be as aggressiv seems obvious that the hunted anim are, in fact, running for their live again refuse to believe we have the r to put such fear into these animals.

We owe it to the animals, thr together in these parks and living at the mercy of man, to allow ther live in peace. If I honestly thought parks were created strictly for m purpose, I would never step foot in ple who fear these animals should er stay out of the parks (there are is in which one can camp all over the ted States without being bothered wild animals) or sanction a few ks strictly for wildlife. Should they n choose to trespass, they, and they ne, would be responsible for the sequences.

Carolyn Pierce
Medford, Massachusetts

have just read "The Great Grizzly pple." It seems a pathetic sign of absurdity of our "civilization" n the National Park Service is kill- grizzly bears not for what they've , but for what they *might* be capa- f doing. The Walker decision ranks ne of the most disgusting ever de- d.

reas become designated as national s because of the extraordinary and ue qualities of nature that are found at particular place. This includes flora and fauna as much as the ogical formations. Preservation of conditions should be of premier rtance.

policy restricting the feeding or ing of wild animals should be in- ed in the national parks. As Clif- J. Martinka pointed out, the le's familiarity with, and feeding izzlies has produced a disastrous ge in the bear's behavior patterns. ons should also be taken to prevent credibly idiotic tourists from pos- heir children with bear cubs for s, while the huge mother bear is irty yards away as I have witnes- n Yellowstone National Park. In wstone I also saw people feeding ears candy bars, Hostess Twin- Jumbo Jacks, french fries, and Kool-Aid — in short, nearly any- they could find that resembled These are usually the people that lain the loudest when an animal them.

for the specific "grizzly bear em" (actually *people* problems), I se the following other solutions:

Education of the public as to the of wild animals — we must be isneyfied."

Close the parks having a "grizzly em" for five years. This will allow the bears to become dependent once more upon their own abilities to obtain food.

3. Then open the parks to shuttle-service tours, but with no unsupervised camping or hiking for an additional five years. During this time the bears can again become accustomed to the sight of humans, but without expecting handouts.

4. When the park opens for camping, have all campers sign National Park Service responsibility waivers and acknowledgements that they camp at their own risk.

Make it a *privilege* not a *right* to enter our national parks.

William Stout
Hollywood, California

Aside from bears caged in zoos or performing in a circus, I had never seen a bear in its habitat until a few years ago, when I had been on a fleeting visit to the Rocky Mountain National Park. As I stood on the paved roadway overlooking the vast valley below, I spotted what first seemed to be a hiker, but in fact was some species of bear. It was awe-inspiring to see this denizen going his way of centuries past in this vast and isolated area that is maintained as a "mental tranquilizer for frazzled city citizens" by their payment of Federal taxes.

But our national parks must be kept safe for those who use them routinely or for that once-in-a-lifetime camping trip! Just as the Indians learned the meaning of our "thunder stick," so must the bears. If they can learn the perfection of their circus performances, they must equally learn to respect the taxpayer or be put in a position less dangerous to him.

The loss of life of one park visitor is not worth the value of all of the bears in our national park system.

Greater creatures than bears trod our wilderness areas until environmental changes caused their demise, and our costly preservation of these park areas and our right to use them safely constitutes an "environmental change." Bears don't vote or pay taxes — the people do!

F. Coleman Greene
Pawling, New York

My name is Matthew Clay. I'm eleven years old, and I'm a reader of *Natural History.* I'm writing becuose [*sic*] you made an era [*sic*] in our August/September 1977 issue. On page 75 the bear standing against the car is a black bear not a grizzly.

Matthew Clay
Portsmouth, Rhode Island

The "grizzly" shown on page 75 of your August/September issue is definitely not a grizzly, but a black bear. On page 77 the bear described as a "young grizzly" is almost certainly a black bear as well. However, all the other bears pictured in "The Great Grizzly Grapple" are genuine grizzly bears!

Henry B. Green
Tarrytown, New York

Community Problems

Mary Ann Borrello and Elizabeth Mathias ("Botanicas," August/September *Natural History*) are obviously sensitive and careful observers. They are also capable analysts of their observations as shown in their fine exposition of the interrelated sources of Puerto Rican religious practices.

Their evaluation of their findings, however, is reactionary in its implications. The spiritualist and animist rites do *not,* in fact, solve any of the Puerto Rican's problems. A community suffering from unemployment and the social disruptions it causes, illiteracy and the multiple barriers it creates to economic advance, excessive population growth and the resultant inability to nurture the child's mind and body — such a community needs to learn, to organize, and to seek rational, long-range solutions to its problems.

As long as religious, social, and anthropological opinions encourage reliance on supernatural means of problem solving, the community is discouraged from learning rational solutions to social problems. I believe that the expensive and wasteful practices described in "Botanicas" are symptoms of a terrible social problem.

Brucia Witthoft
Framingham State College
Lexington, Massachusetts

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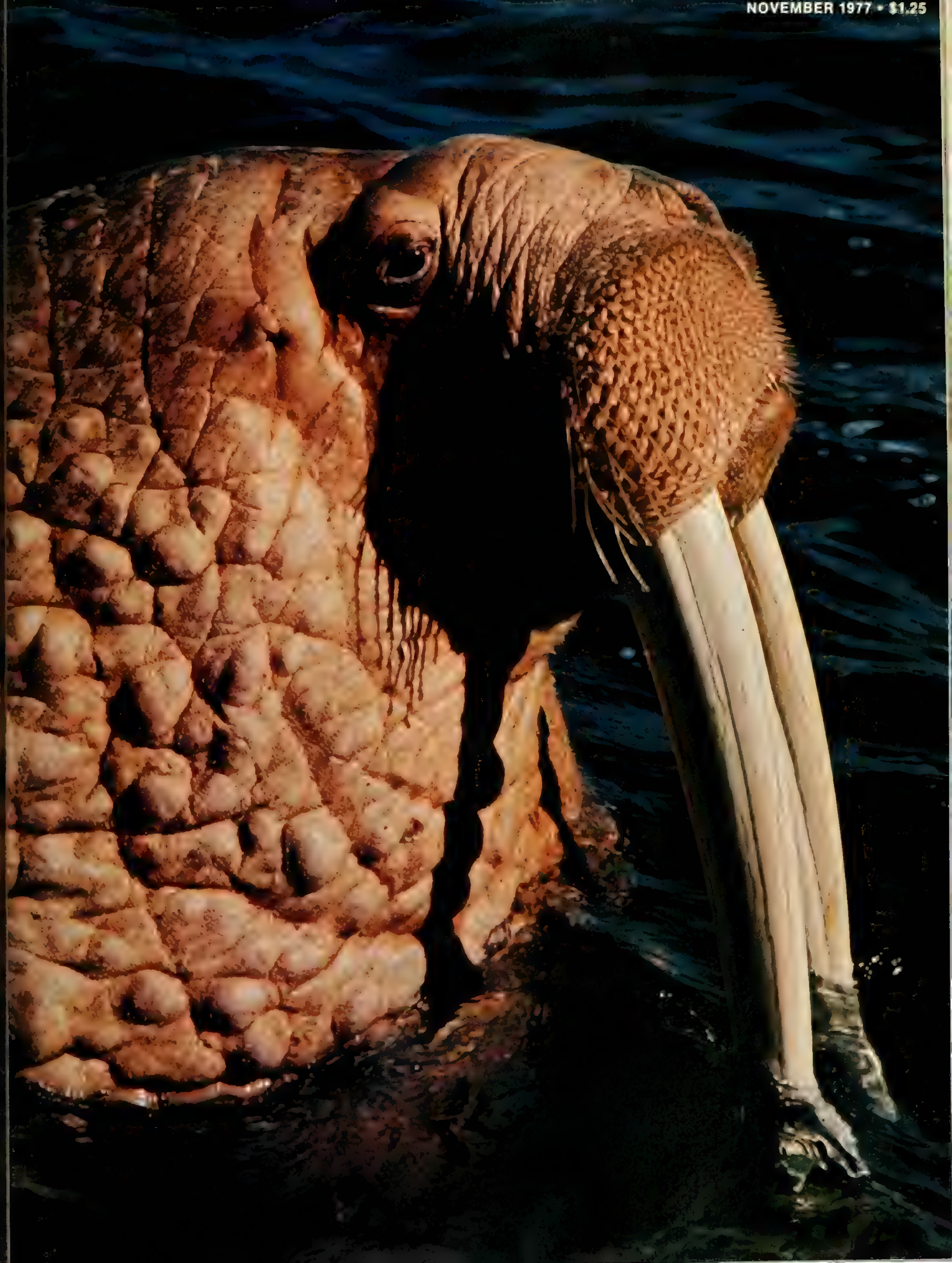

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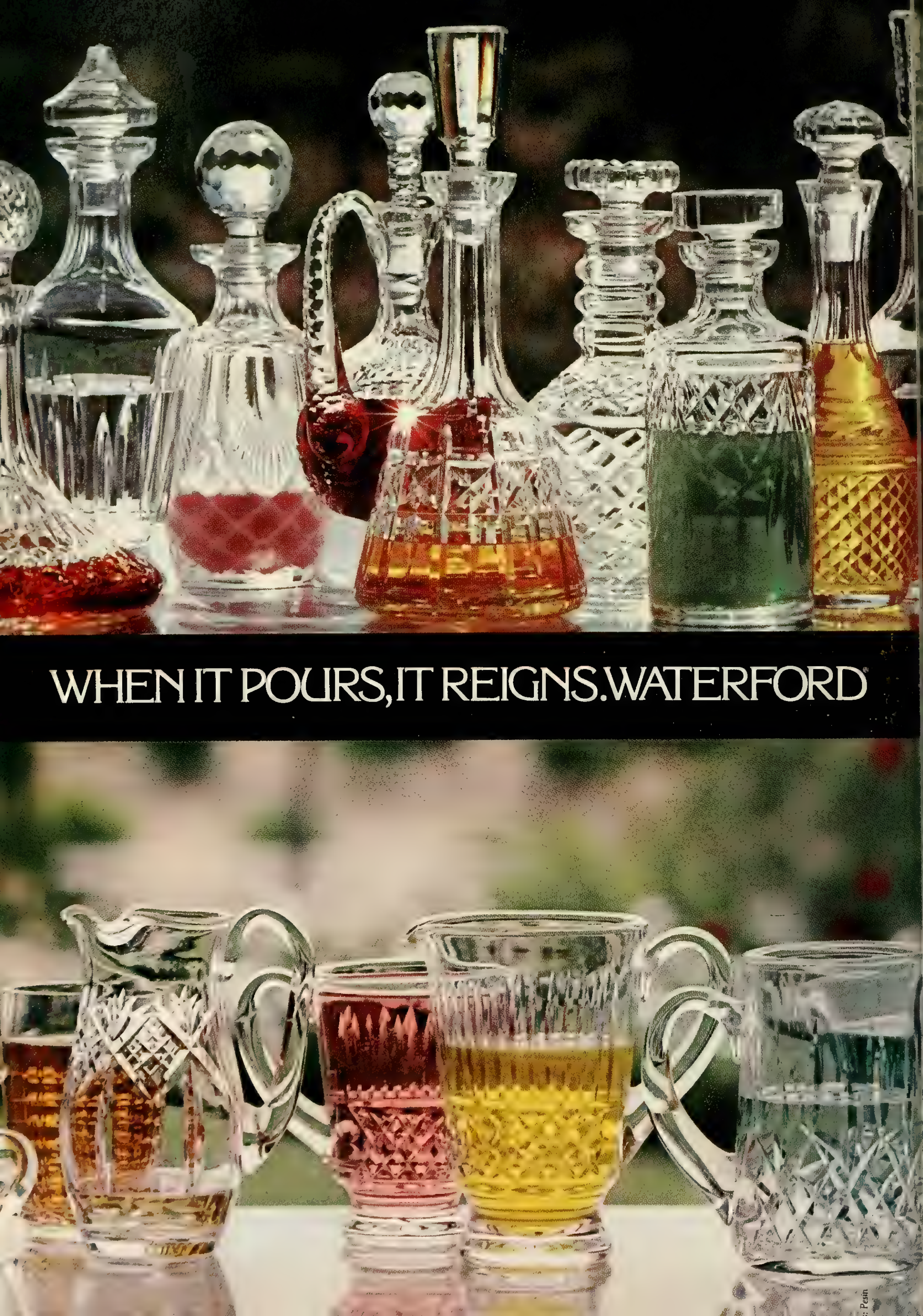
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The production of "The Cousteau Odyssey" specials for PBS is made possible by a grant from Atlantic Richfield Company to KCET, Los Angeles, expressly for the funding of the broadcasts. The specials are produced by Captain Cousteau and Philippe Cousteau in association with KCET.

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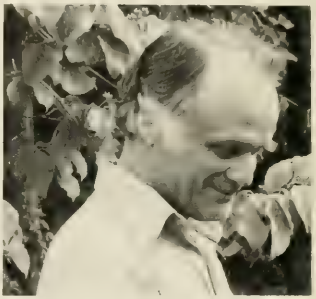
uthors

Both **C. David Rollo,** left, and **illiam G. Wellington,** right, are as- ciated with the Institute of Animal source Ecology at the University of itish Columbia. Rollo, a doctoral ndidate, is particularly interested in homing and competitive behavior of restrial mollusks. He has studied gs in Ontario cornfields and recently ntributed to a mollusk survey of uthern British Columbia.

Wellington is director of the institute and professor of plant science and resource ecology at the university. He has contributed frequently to *Natural History*, generally on the impact that individual differences in animal or insect behavior have on survival of the local populations. His most recent article was "Life at the Cloud Line" (October 1976), about animal and insect adaptation to mountain weather.

A writer, photographer, and author- on the human and animal life of the north, **Fred Bruemmer** spends al- st as much time in the Arctic as he es at home in Montreal. Over a thir- n-year period, he has visited most of areas where walruses are still found: ble Island, off Nova Scotia; Spitsbergen; northern Greenland; many of the Canadian high arctic islands; Hudson Bay; and Little Diomede Island in the Bering Strait. On Little Diomede, the subject of his last article for *Natural History* ("Life on a Cold Rock," March 1977), he noted the migration of Pacific walruses.

F. Herbert Bormann and **Gene E. Likens** are the originators of the Hubbard Brook Ecosystem Study of the mountains of New Hampshire. One of the oldest and most intensive ecosystem studies in the world, the work conducted under its auspices has produced volumes of information on the ecology, chemistry, hydrology, and general biology of eastern forests. As principal investigators at Hubbard Brook, Bormann and Likens are hoping to determine more about the relationship between forests and lakes and the effects of air pollution on forest growth. The authors report that part of the study's success is due to their working well together—they have not had a serious argument in thirteen years. Bormann, above, is professor of forest ecology at Yale University; Likens, below, is professor of ecology at Cornell University.



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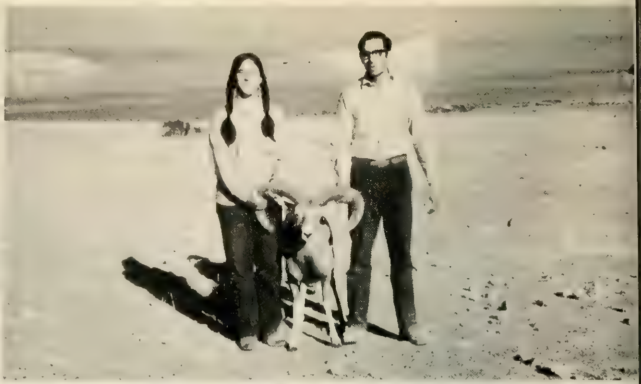

"I became interested in the natural history of Asia at the age of fourteen," writes **Raul Valdez**, an assistant professor at New Mexico State University. Part of that interest recently reached fruition through his field work on the behavior and ecology of mouflon sheep in Iran, a subject on which he is writing a book. Valdez has also conducted research in Mexico, Honduras, Nicaragua, and El Salvador. His plans call for doing ecological studies of native and introduced ungulates in New Mexico.

Coauthor **Leticia V. Alamia** is biologist with the Texas Park an Wildlife Service. In her capacity as research ecologist with the Iran De partment of the Environment, she a sisted her husband, Raul Valdez, on h wild sheep studies from 1971 to 197 Her past work has included an invest gation of the renesting activity c white-winged doves in the lower Ri Grande Valley of Texas. In her spa time, Alamia is a serious natur photographer.

Alan M. Beck is director of New York City's Bureau of Animal Affairs. That division of the Department of Health handles the city's problems concerning all animals except rats. This past summer, while other New Yorkers talked about the heat wave, the blackout, and Son of Sam, Beck worried about a rising bat population, and called for a bat alert to avert cases of rabies. His last contribution to *Natural History* was "The Life and Times of Shag, Feral Dog in Baltimore" published i October 1971.

Now at the Behavioral Science Foundation in St. Kitts, coauthor **Phili Marden** came to New York fron Hampshire College in Amherst, Mas sachusetts, to do a senior research proj ect on a primate population. Bec suggested that Marden observe instea his neighborhood's street dwellers.

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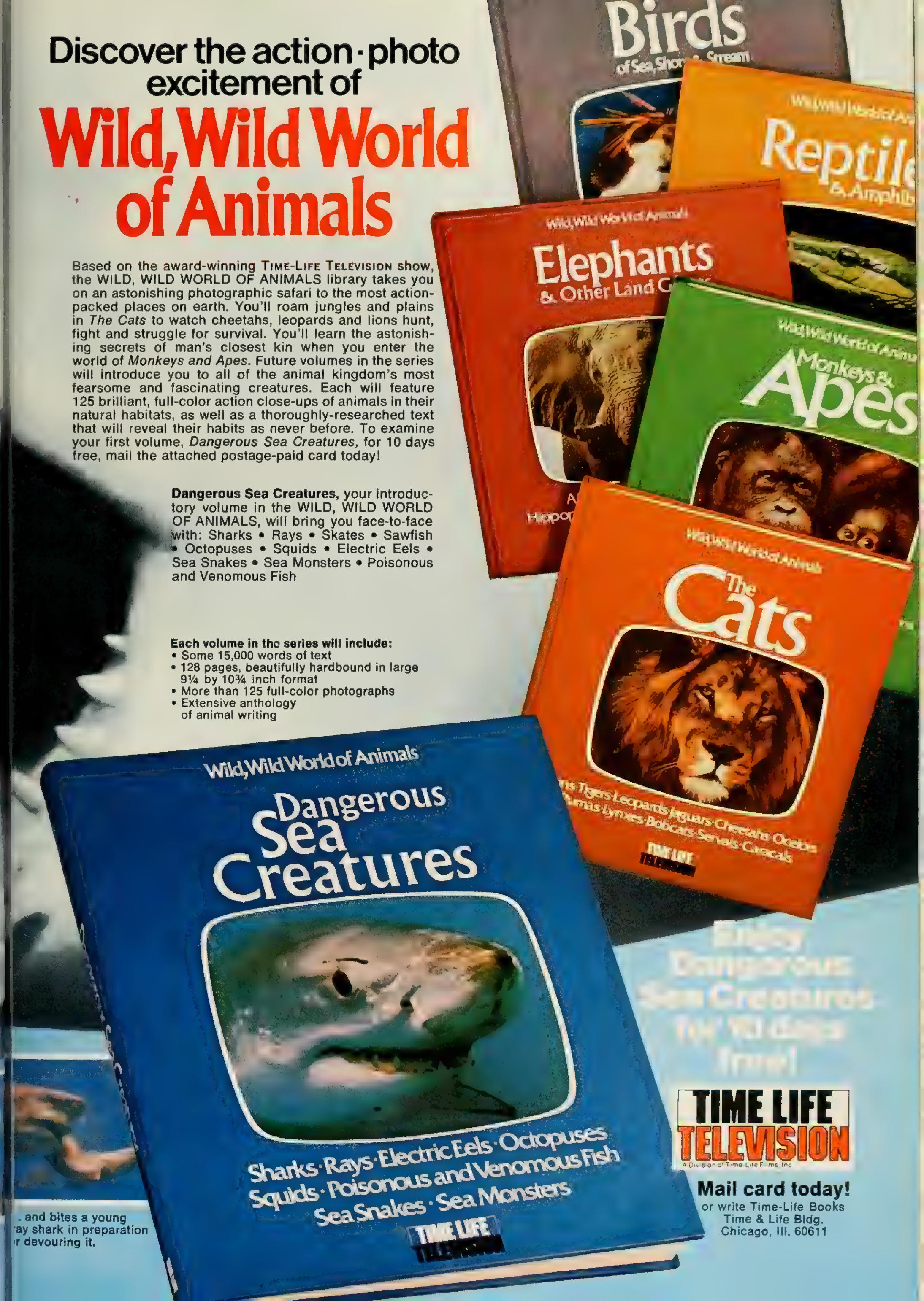
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Can Animals Anticipate Earthquakes

by Evelyn Shaw

When dogs start to howl
and cattle to bellow; when
rats run the streets and
catfish jump from
ponds . . . watch out!

Unusual behavior by animals as divergent as ants, parakeets, sardines, and yaks has been noted in many countries prior to the onset of earthquakes. Some of the behavior, as reported from China, Japan, the United States, Guatemala, and Italy, took place weeks before the quake, some only hours or minutes.

Observers recalled that chickens and pigeons balked at entering their coops; cattle bellowed mournfully and refused to graze; dogs howled in chorus all over town; rats scurried from their hideouts and marched fearlessly through houses; catfish leaped out of their ponds; horses neighed, trembled, and ran wildly around their corrals; and snakes slithered from their hibernation holes only to freeze to death on winter ice.

Russian scientists, who have recently become interested in using animal behavior to predict all kinds of natural disasters, report that before tremors and storms, shrimps crawled on dry land, ants picked up their eggs and moved in mass migrations, and pheasants chorused an alarm. Furthermore, a Soviet geophysicist has claimed that human beings, too, may have a disaster-warning mechanism and cited 1948 medical reports from one area indicating a dramatic upsurge in heart complaints among patients whose cardiograms were normal. Within two months, an earthquake devastated the region and the heart complaints subsequently disappeared (perhaps the patients were dead?).

In 1964, the year of the great Alaska earthquake, kodiak bears emerged from hibernation two weeks before their normal winter sleep would have ended and headed for the hills. In 1975, in California, an earthquake of 6.0 on the Richter scale, struck the Oroville region, a rural area about eighty miles northwest of Sacramento. Two days later, a visiting reporter was overwhelmed by accounts of anomalous behavior of farm animals, seen minutes, as well as weeks, before the event. A scientist attached to the Max Planck Institute of Berlin visited northeastern Italy after the disastrous Friuli earthquake of 1976. While there he was told innumerable tales of strange animal behavior, such as fowl refusing to roost, cattle panicking in their barns, mice and rats leaving their hiding places, and cats moving out of the area.

Finally, a man in San Francisco reported the odd behavior of pet bullfrogs that had metamorphosed just two weeks earlier. The frogs were housed in an aquarium attached to a water faucet by a copper wire. One Sunday, the man noticed that the frogs had increased their jumping activity and were hopping about more than usual. But he was particularly baffled the next day when he heard the young frogs croaking loudly at noon and then saw them swimming in clockwise circles. That evening at 7:45 an earthquake of magnitude 4.7 on the Richter scale struck the Bay area. Normally, frogs vocalize as adults. Males croak during the reproductive season and occasionally before an oncoming storm. Females sometimes grunt when they are captured or are otherwise disturbed. Consequently, the vocalizations of the young frogs was out of the ordinary and may have been a reaction to some otherwise undetected physical stimulus.

These reports, no matter how widely separated their places and times of origin, share certain attributes in common: increased animal irritability and vocalization, restlessness, and greater activ-
ity often leading to migrations.
though anecdotal in nature, the tal
have enough substance to cause t
People's Republic of China to ta
them seriously. The Chinese have d
tributed publications to farmers a
other rural residents instructing them
what to watch for in their animals
that every household can join in obs
vation and "the people's war agai
earthquakes" will be won. The g
ernment of the People's Repub
claims that the location and time of o
gin of about fifteen earthquakes ha
been successfully foretold in rece
years. The predictions have reli
heavily on bizarre behavior amo
domestic animals, which can be eas
observed without technical equipme
or special training.

The Chinese are particularly pro
of their prediction of the maj
earthquake in Haicheng on February
1975. The town was totally destroy
but very few persons were killed, ev
though about a million lived near t
quake's epicenter, because the popu
tion had been evacuated. Forem
among the precursory events of th
earthquake was the discovery in mi
December that normally hibernati
snakes had left their holes and frozen
death on the ice. In the month precedi
the major tremors, the earthquake al
became more intensive as "hundreds
thousands" of people reported o
animal behavior, centered on an a
that later proved to be the quake's e
center.

Dramatic though these anecdotal
counts may be, a geophysicist at t
California Institute of Technology h
pointed out that concomitant physi
events, such as rapidly changi
ground tilt, drops in water level, a
changes in the earth's geomagne
field, could also lead to successful p
diction. For all their success in predi
ing the Haicheng earthquake of 197

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ie Chinese could not predict a much iore devastating quake on July 28,)76, which leveled the much larger ty of Tangshan, and killed an esti- iated 750,000 to 850,000 persons.

Reports of anomalous animal behav- ir associated with earthquakes are not :cent; in China they date back to ynasties of 3,000 years ago. And in eventeenth-century Japan, giant cat- sh were thought to cause earthquakes ; they churned their massive bodies ithin the earth's core. These mythical pisodes were chronicled by the artist ishiki-e in his colored woodblock ints. Although in the realm of folk- re, such beliefs are founded on facts. atfish normally are bottom dwellers, it they have been seen to leap out of e water before some earthquakes and ive also been found in unusual ibitats such as the middle of rivers, dicating that they had left the safety of eir muddy hideaways.

In the 1930s, earthquake swarms oc- irred with such regularity in Japan that veral scientists were able to test the nsitivity of catfish to earthquake pre- irsors. Working at the Asamushi arine Biological Station, two re- archers discovered a correlation be- 'een the response of catfish to a me- ianical stimulus and the subsequent currence of an earthquake. The tfish were kept in aquariums filled ith water drawn directly from a local eek. The aquariums were installed on ooden tables on which the researchers pped three times a day. Their studies owed that if the catfish did not react to e tapping, no earthquake tremor ould occur; but if they did respond — jumping — a slight tremor would ke place, usually six to eight hours er. The researchers claimed a corre- ondence of 80 percent between the tfish reaction and the occurrence of rthquakes, indicating sensitivity to en slight seismic disturbances.

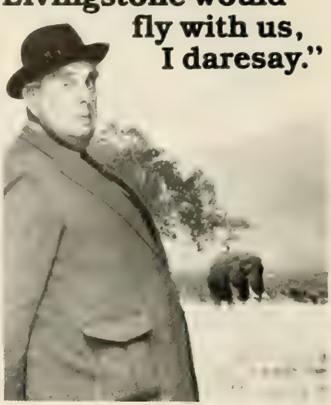
Subsequent Japanese experiments th catfish were aimed at discovering iether the fish responded to electrical well as seismic stimuli. Electrodes re inserted in the aquariums and the ctric fields surrounding the fish were inipulated. Some relationship emed to exist between catfish sen- ivity to minute electrical changes, on order of microamperes, and anges in the earth's electric field as- ciated with the occurrence of thquakes.

Another Japanese scientist of the 30s examined the relationship be- een daily fish catch and seismic activ- in Izu Province, southwest of Tokyo. By carefully scrutinizing six years of catch data he reported a positive correlation between abundant catches of horse mackerel and seismic activity. He proposed that seismic shocks may have induced more fish to enter the fishing grounds or may have altered the migratory pattern of plankton or affected the chemistry of seawater as a result of disturbances to the sea floor. One Japanese ichthyologist was surprised to find the stomachs of sardines, normally upper-layer dwellers, engorged with bottom-adhering diatoms a day before the great Sanriku earthquake of 1933. Three days after the earthquake, the sardines' stomachs were once again filled with their normal diet of upper-layer plankton. Furthermore, the catch of a rare deep-sea fish some hours after the earthquake led to the belief that seismic disturbances on the sea floor were triggering the upward migration of bottom dwellers.

With earthquake prediction in mind, a new look was taken at data collected at the Stanford Outdoor Primate Facility (SOPF) for the purpose of studying long-term changes in chimpanzee behavior associated with maturation and hormonal variations. Several intriguing deviations in behavioral frequencies were found to have taken place one day before a mild earthquake occurred in the vicinity of the facility, located close to the San Andreas fault. Observers reported a "significant elevation of restlessness," as well as significant increases and decreases in the time the chimpanzees spent in certain areas of the facility. Similarly, a day before another earthquake, increased restlessness was also observed, but in that case space-utilization changes occurred only on the day of the quake. Although of slight magnitude, these earthquakes were apparently sensed by the chimpanzees about eight hours before they took place.

Chinese scientists in Peking have been probing the prediction potential of pigeons. They report that tiny ellipsoidal bodies in pigeons' legs are sensitive to vibrations of very small amplitude, a fraction of a micron. These tiny bodies are connected to each other by clusters of nerves. That these bodies might detect earthquake precursors was shown in experiments in which some pigeons had the nerves to these structures severed and other pigeons were kept intact. Prior to an earthquake of magnitude 4.0 Richter, the unaltered birds flew about wildly, while those whose nerves were severed seemed to be unaware of the impending quake and remained calm.

"Today, Stanley and Livingstone would fly with us, I daresay."



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Provocative as these results may be, they have not yet been verified in this country.

Since the probability that any animals would be subject to intense seismic stimuli during their lifetimes seems fairly remote, it is difficult to believe that they have developed specific systems for the recognition of earthquake cues. Their sensing of precursory earthquake phenomena is probably effected through sensory detectors that are used primarily to gather information about daily environmental changes in their respective milieus.

Assuming, then, that no specific earthquake detectors exist, and that detection takes place through available sensory equipment, one major problem in ascertaining what particular stimuli animals react to is that the cluster of physical components involved in earthquakes is not necessarily identical from one earthquake to the next. Earthquakes have individual characteristics: modifications occur in acoustic waves, air-pressure levels, the tilt of the land, electrical conductivity, electromagnetic fields, electrostatic discharges, gas emissions, groundwater level, and temperature, for example, but these events do not always appear in identical patterns. The time of onset, frequency, duration, and magnitude of each may vary, as well as which particular physical events are present. To confound the experimenters further, physical changes that take place are often of such small magnitude that they fall within the range of normal fluctuations regularly experienced by the animal. To detect such changes would require the animal to distinguish an earthquake signal from an array of background "noise," perhaps through a filtering system. Moreover, animal responses tend to differ according to the season, time of day, age, and previous experience. Thus, given that we do not have complete information about animal detection capabilities, and that our knowledge of the physical events preceding earthquakes is also incomplete, we can only guess as to what the animals are actually sensing.

Animal sensors that discern light, sound, odor, touch, and temperature are well known. Less well known are sensors that detect changes in the earth's magnetic field. That they exist is currently being revealed by scientists studying orientation, navigation, migration, and homing among birds, bees, and other species. For those who believe in animals as earthquake predictors, the discovery that some animals distinguish small shifts in magneti fields is very exciting since it has lon been thought that variation i geomagnetic fields is intimately involved with earthquakes.

The earth's geomagnetic field i measured in units known as gammas One gamma (which is a very wea field) is one fifty-thousandth of the tota average terrestrial field. At the earth' surface, the geomagnetic field is variable. When analyzing the sensitivity o animals to earthquakes it is therefor important to remember that within thei normal daily foraging adventures, animals may be subject to magnetic field that vary by as much as several hundre gammas. More important perhaps is th diurnal variation of thirty to fifty gammas that results from the interactio between the earth's magnetic field an charged particles in the solar wind Thus the small changes of one to te gammas recorded in local magneti fields before earthquakes are within th range of normal daily fluctuations. Although the amplitude of these norma fluctuations may be small, we do no know their frequencies. With these constraints in mind, let us examine research that reveals the capacity of som animals to detect magnetic fiel changes, but does not indicate wha their magnetic sensors may be.

Basically, the research technique consist of altering magnetic fields – bringing the field to zero or otherwis altering it artificially. The behaviora changes considered to be indicators o the awareness of magnetic change consist of the animals pointing, turning, and moving in a direction differen from control animals, in a manner mor or less consistent with predictions mad by the experimenter.

During the early 1960s, a biologist a Northwestern University recorded th directional responses of mud snails planarian worms, protozoans, and frui flies to manipulated fields with variations in magnitude comparable to thos of natural terrestrial magnetism. Th animals' behavioral changes were consistent, but rather subtle, and the result were not at first generally accepted Since then, however, other researcher have achieved more convincing result and many animal behaviorists now believe that some animals are indeed sensitive to weak magnetic fields.

In the early 1970s the sensitivity o honeybees to magnetic fields was demonstrated by the work of German scientists who had studied with Nobel laureate Karl von Frisch. As long ago as th 1920s, von Frisch established that hon

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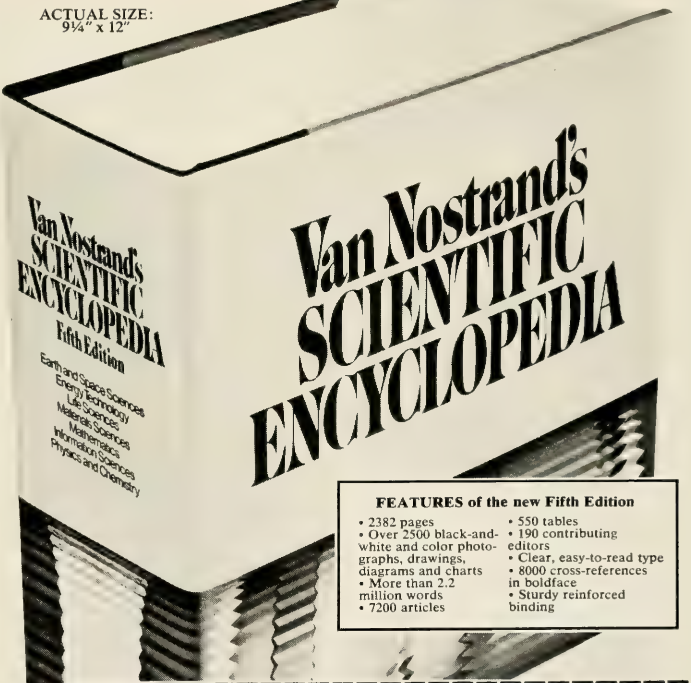

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eybees communicate the distance and direction of food supplies to members of their colonies by means of dances. The direction of the dance within the hive relative to the angle of the sun informs fellow hive members of the direction of nectar-laden flowers; the duration of the waggle in the dance indicates the distance.

Using that information as a model, two German investigators discovered what seemed to be an "error." The direction of the dance was always a little off, yet the bees found the food with unerring accuracy. Obviously, some factor in addition to the position of the sun was involved. The researchers tracked the diurnal variations in the strength of the earth's magnetic field and found that the so-called errors in the bees' dances corresponded to those magnetic changes. If the earth's magnetic field was artificially reduced to zero within the hive, the researchers showed that the direction of the dance followed the route they predicted from the model. Moreover, the bees evidently sensed magnetic fluctuations as small as ten gammas, again well within the range of normal fluctuations in terrestrial magnetism. The bees' magnetic detectors, however, remain unknown.

Homing pigeons similarly sense changes in the magnetic field and may use the information for orientation on overcast days. A research team at Cornell University found that although the sun's position is the main directional cue, pigeons still navigate successfully on cloudy days. Small bar magnets attached to the pigeons' backs had no effect on their navigation on sunny days but caused confusion and interfered with typical directional choice when the birds were released some distance from home on cloudy days. Researchers at the State University of New York, at Stony Brook actually forced a new orientation, rather than merely disrupting the expected one, by attaching electrical coils to pigeons. When the current flowed counterclockwise in the coils of some birds and clockwise in the coils of others, the birds headed in opposite directions from each other. It thus appears that cues from the magnetic field may be used as directional guides when the sun is hidden.

In other research at Cornell involving indigo buntings, the birds shifted their orientation as the magnetic field was deflected. This tendency disappeared as the migratory season waned; then the birds ignored information from both natural and artificially deflected magnetic fields. A European scientist and his associates also demonstrated magnetic field sensitivity among European robins. The birds selected migratory directions according to the magnetic field as well as the season. Working with ring-billed gull chicks, an ornithologist at Northern Illinois University disrupted their preferred south-southeast orientation inside a circular arena when the normal magnetic field was changed. If it was increased to forty gammas or more — that of a moderately severe magnetic storm — the tendency to orient directionally was reduced. Nevertheless the ornithologist was careful to emphasize the tenuous nature of such experiments since they tend to generate disturbances and disorientation, but do not necessarily force the birds to choose another heading and do not affect all the birds.

Recent field studies, however, seem, at least indirectly, to reaffirm the laboratory results. One field project visually tracked nocturnally migrating passerine birds and correlated their loss of accuracy in orientation with disturbances in the magnetic field. But the investigators cautioned that magnetic field disturbances may not directly affect the birds but may act through such intermediaries as weather patterns, which are also modified by the earth's magnetic activity.

Another field study found that man-made electromagnetic field fluctuations caused turning or changes in altitude among nocturnally migrating birds. Evidently, the birds rapidly detected the low-frequency fluctuating electromagnetic field (in the other studies reported above, the fields were constant). Tracking with radar, the investigators recorded the flight paths when the antenna system was off, was on, and during changes of current. The greatest deviation from linear paths occurred when the antenna was on or was changing currents. Although cautious about these results, the investigators believe that birds detect low-frequency electromagnetic variations within a few seconds and that orientation at night can be altered by the local electromagnetic field.

Evidence thus accumulates that birds are capable of sensing small fluctuations in magnetic fields. Animal behaviorist William T. Keeton of Cornell University, who conducted the experiments on homing pigeons, believes that experimental refinements may eventually demonstrate that birds and bees are capable of detecting changes in magnitude as small as one gamma, well below the amplitude of the earth's field. In addition, Keeton points out that ho ing pigeons sense small shifts in b ometric pressure and can also dete extreme low-frequency sounds—phy ical events that are associated wi earthquakes.

Although the studies of birds a bees were not directed at detecting se sitivity to earthquakes, they sugge fruitful directions for further inqui along that line. Recent research on t sensory perception of fish has also n been directed toward earthquake pr diction. Nevertheless, fish, like bir and bees, have sensory capacities th may permit them to react to earthqua precursors. Fish have special senso equipment called the lateral line sy tem, an arrangement of canals that ru down the fish's flanks. Its basic senso detect changes in nearby water mov ment and low-frequency vibrations. some fish, the sensors have developed new function, that of electroreceptio

This rather remarkable attribute a lows for the detection of extreme small changes in voltage. All fish pr duce constant bioelectric fields arou their bodies, and some marine anima are acutely sensitive to these field Sharks and rays, for example, ha minute saclike receptors called ampu lae of Lorenzini, which they use to pi point their prey. A series of wel controlled experiments has shown th sharks and rays can detect a flatfis submerged in the sand simply by di tinguishing its bioelectric field, whe all visual, chemical, and mechanic cues were masked. Electrodes emitti the same voltage as a flatfish elicited th same hunting behavior. Endowed wi electroreceptors, catfish also have th talent, locating live goldfish in the a sence of all stimuli except bioelectr ones.

Granted that many animals seem t be acutely sensitive to various premon itory events associated with eart quakes, the basic question remains how this behavior can be put to use i earthquake prediction. Can we lea just what stimuli particular species a reacting to? Can we then design instru ments of comparable discriminatio and sensitivity? And even with suc instruments, do the premonitory even take place sufficiently in advance major tremors to make long-term pr dictions, and the concomitant evacu tion of large populations, a realist possibility? Only further experiment tion will provide the answers.

Evelyn Shaw is a biologist who teach animal behavior at Stanford Universit

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by Stephen Jay Goul

The Telltale Wishbone

Your Thanksgiving feast might feature a member of the class Dinosauria

When I was four I wanted to be a garbageman. I loved the rattling of the cans and the whir of the compressor; I thought that all of New York's trash might be squeezed into a single, capacious truck. Then when I was five, my father took me to see the *Tyrannosaurus* at the American Museum of Natural History. As we stood in front of the beast, a man sneezed; I gulped and prepared to utter my *Shema Yisrael*. But the great animal stood immobile in all his bony grandeur, and as we left, I announced that I would be a paleontologist when I grew up.

In those distant days of the late 1940s, there wasn't much to nurture a boy's interest in paleontology. I remember *Fantasia,* Alley Oop, and some fake-antique metal statues in the Museum shop, priced way above my means and not very attractive anyway. Most of all, I recall the impression conveyed in books: *Brontosaurus,* wallowing its life away in ponds because it couldn't support its weight on dry land; *Tyrannosaurus,* fierce in battle but clumsy and ungainly in motion. In short, slow, lumbering, pea-brained, coldblooded brutes. And, as the ultimate proof of their archaic insufficiency, did they not all perish in the great Cretaceous extinction?

One aspect of this conventional wisdom always bothered me: why had these deficient dinosaurs done so well —and for so long? Therapsid reptiles, the ancestors of mammals, had become diverse and abundant before the rise of the dinosaurs. Why didn't they, rather than dinosaurs, inherit the earth? Mammals themselves had evolved at about the same time as dinosaurs and had lived for 100 million years as small animals in the interstices of a dinosaur's world. Why, if dinosaurs were so slow, stupid, and inefficient, did mammals not prevail right away?

A striking resolution has been suggested by several paleontologists during the past decade. Dinosaurs, they argue, were fleet, active, and warmblooded. Moreover, they have not yet gone the way of all flesh, for a branch of their lineage persists in the branches— we call them birds.

A year ago, I vowed that I would not write about warmblooded dinosaurs in this column: the new gospel had gone forth quite adequately in television, newspapers, magazines, and popular books. The intelligent layperson, that worthy abstraction for whom we write, must be saturated. But I relent, I think for good reason. In nearly endless discussions, I find that the relationship between two central claims — dinosaur endothermy (warmbloodedness) and dinosaurian ancestry of birds — has been widely misunderstood. I also find that the relationship between dinosaurs and birds has provoked public excitement for the wrong reason, while the right reason, usually unappreciated, neatly unites the ancestry of birds with endothermy of dinosaurs. And this union supports the most radical proposal of all—a restructuring of vertebrate classification that removes dinosaurs from Reptilia, sinks the traditional class Aves (birds), and designates a new class, Dinosauria, uniting birds and dinosaurs. Terrestrial vertebrates would fit into four classes: two coldblooded, Amphibia and Reptilia, and two warmblooded, Dinosauria and Mammalia. I have not made up my own mind about this new classification, but I appreciate the originality and appeal of the argument.

The claim that birds had dinosaurs as ancestors is not so tumultuous as might first appear. It involves no mo than a slight reorientation of a bran on the phyletic tree. The very clo relationship between *Archaeoptery* the first bird, and a group of small din saurs called the coelurosaurs has nev been doubted. T. H. Huxley and mo nineteenth-century paleontologists a vocated a relationship of direct desce and derived birds from dinosaurs.

But Huxley's opinion fell into disf vor during this century for a simple, a apparently valid, reason. Comple structures, once totally lost in evol tion, do not reappear in the same for This statement invokes no mysterio directional forces in evolution, b merely asserts a claim of mathematic probability. Complex parts are built hundreds of genes, interacting in con plex ways with the entire develo mental machinery of an organism. dismantled by evolution, how cou such a system be built again, piece piece? The rejection of Huxley's arg ment hinged on a single bone — t clavicle, or collarbone. In birds, inclu ing *Archaeopteryx,* the clavicles a fused to form a furcula, better known friends of Colonel Sanders as a wis bone. All dinosaurs, it appeared, h lost their clavicles; hence, they cou not be the direct ancestors of birds. A unimpeachable argument if true. B negative evidence is notoriously pro to invalidation by later discovery.

Still, even Huxley's opponents cou not deny the detailed structural simila ity between *Archaeopteryx* and the co lurosaurian dinosaurs. So they opt for the nearest possible relationship b tween birds and dinosaurs — comm derivation from a group of reptiles th still possessed a clavicle, subsequent lost in one line of descent (dinosaur and strengthened and fused in anoth (birds). The best candidates for co

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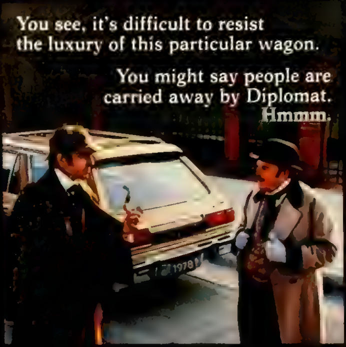

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mon ancestry are a group of Triassi thecodont reptiles called pseudosuchians.

Many people, on first hearing tha birds might be surviving dinosaurs think that such a striking claim mus represent a complete discombobulatio of received doctrine about vertebrat relationships. Nothing could be furthe from the truth. All paleontologists advocate a close affinity between dinosaurs and birds. The current debate centers about a small shift in phyleti branching points: birds either branche from pseudosuchians or from the descendants of pseudosuchians—the coelurosaurian dinosaurs. If bird branched at the pseudosuchian level they cannot be labeled as descendant of dinosaurs (since dinosaurs had no yet arisen); if they evolved from coelurosaurs, they are the only survivin branch from a dinosaur stem. Sinc pseudosuchians and primitive dinosaurs did not look very different, th actual point of branching need not sa much about the biology of birds. N one is suggesting that hummingbird evolved from *Stegosaurus* or *Triceratops*.

The issue, thus explicated, may no seem rather ho-hum to many readers although I shall soon argue (for a different reason) that it isn't. But I want t emphasize that these twists of genealogy are of utmost concern to professional paleontologists. We care ver much about who branched from whom because reconstructing the history o life is our business, and we value ou favorite creatures with the same lovin concern that most people invest in thei families. Most people would care ver much if they learned that their cousi was really their father — even thoug the discovery carried few insights abou their biological construction.

Yale paleontologist John Ostrom ha recently revived the dinosaurian theory He restudied every specimen of *Archaeopteryx* — all five of them. First o all, the main objection to dinosaurs ha already been countered. At least tw coelurosaurian dinosaurs had clavicle after all, so they are no longer debarre as progenitors of birds. Secondly, Ostrom documents in impressive detail th extreme similarity in structure betwee *Archaeopteryx* and coelurosaurs. Sinc many of these common features are no shared by pseudosuchians, they eithe evolved twice (if pseudosuchians ar ancestors of both birds and dinosaurs or they evolved just once and birds inherited them from dinosaur ancestors.

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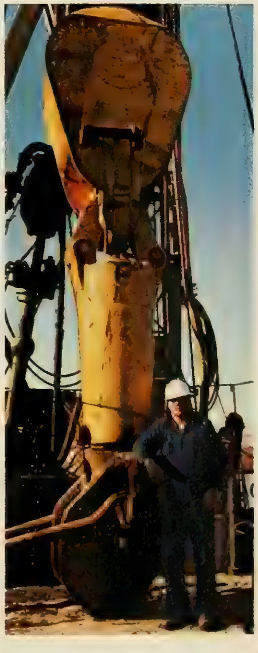

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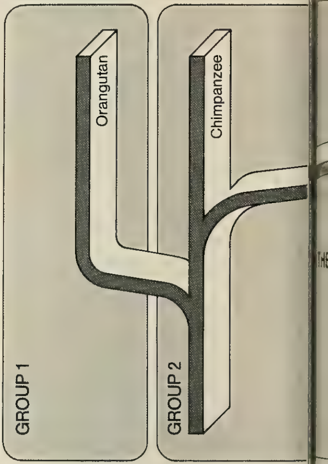
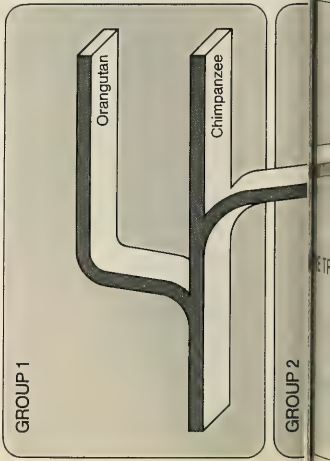
tures is very common; we refer to it as parallelism, or convergence. We anticipate convergence in a few adaptively necessary structures when two groups share the same mode of life—consider the saber-toothed marsupial carnivore of South America and the placental saber-toothed tiger. But when we encounter a detailed, part-by-part correspondence for minutiae of structure without clear adaptive necessity, we invoke a hypothesis of shared possession by descent. Therefore, I accept Ostrom's revival. The only major impediment to dinosaurs as ancestors of birds had already been removed with the discovery of clavicles in some coelurosaurian dinosaurs.

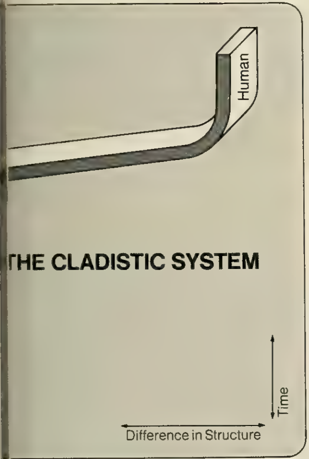
Birds evolved from dinosaurs, but does this mean, to cite the litany of some popular accounts, that dinosaurs

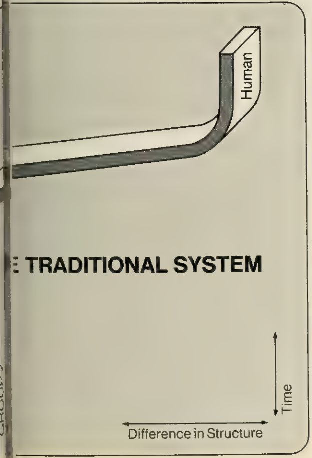




re still alive? Or, to put the question nore operationally, shall we classify inosaurs and birds in the same group, vith birds as the only living repreentatives? Paleontologists R. T. Baker and P. M. Galton advocated this ourse when they proposed the new verebrate class Dinosauria to accommoate both birds and dinosaurs.

A decision on this question involves basic issue in taxonomic philosophy. Sorry to be so technical about such a ot subject, but severe misunderstandngs can arise when we fail to sort fornal questions in taxonomy from bioogical claims about structure and physology.) Some taxonomists argue that ve should group organisms only by paterns of branching: if two groups branch rom each other and have no descenants (like dinosaurs and birds), they





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must be united in formal classification before either group joins another (like dinosaurs with other reptiles). In this so-called cladistic (or branching) system of taxonomy, dinosaurs cannot be reptiles unless birds are as well. And if birds are not reptiles, then according to the rules, dinosaurs and birds must form a single, new class.

Other taxonomists argue that branching points are not the only criterion of classification. They weigh the degree of adaptive divergence in structure as well. In the cladistic system, cows and lungfish have a closer affinity than lungfish and salmon because the ancestors of terrestrial vertebrates branched from the sarcopterygian fishes (a group including lungfish) after the sarcopts had already branched from the actinopterygian fishes (standard bony fishes, including the salmon). In the traditional system, we consider biological structure as well as branching pattern, and we may keep lungfish and salmon together as fish because they share so many features as aquatic vertebrates. The ancestors of cows experienced an enormous evolutionary transformation, from amphibian to reptile to mammal; lungfish stagnated and look pretty much as they did 250 million years ago.

The traditional system recognizes unequal evolutionary rates after branching as a proper criterion of classification. A group may win separate status by virtue of its profound divergence. Thus, in the traditional system, mammals can be a separate group and lungfish can be kept with other fish. Humans can be a separate group and chimps can be kept with orangutans (even though humans and chimps share a more recent branching point than chimps and orangs). Similarly, birds can be a separate group and dinosaurs kept with reptiles, even though birds branched from dinosaurs. If birds developed the structural basis of their great success after they branched from dinosaurs, and if dinosaurs never diverged much from a basic reptilian plan, then birds should be grouped separately and dinosaurs should be kept with reptiles, despite the genealogical history of branching. So, we finally arrive at the central question and at the union of this technical issue in taxonomy with the theme of warmblooded dinosaurs. Did birds inherit their primary features directly from dinosaurs? If they did, Bakker and Galton's class Dinosauria should probably be accepted, despite the adherence of most modern birds to a mode of life (flight and small size) not wonderfully close to that of most dinosaurs. After all, bats whales, and armadillos are all mammals.

Consider the two cardinal feature that provided an adaptive basis fo flight in birds — feathers for lift an propulsion and warmbloodedness fo maintaining the consistently high level of metabolism required by so strenuou an activity as flight. Could *Archaeopteryx* have inherited both these feature from dinosaur ancestors?

R. T. Bakker has presented the mos elegant brief for warmblooded dinosaurs in the April 1975 issue of *Scientific American*. He rests his controversial case on four major arguments:

1. The structure of bone. Coldblooded animals cannot keep their body temperature at a constant level: it fluctuates in sympathy with temperatures in the outside environment Consequently, coldblooded animal living in regions with intense seasonality (cold winters and hot summers) develop growth rings in oute layers of compact bone — alternating layers of rapid summer an slower winter growth, just as i trees. Warmblooded animals do no develop rings because their interna temperature is constant in all seasons. Dinosaurs from regions of intense seasonality do not have growt rings in their bones.
2. Geographic distribution. Larg coldblooded animals do not live a high latitudes (far from the equato because they cannot warm u enough during short winter days an are too large to find safe places fo hibernation. Some large dinosaur lived so far north that they had t endure several months of no sun a all during the winter.
3. Fossil ecology. Warmblooded carnivores must eat much more tha coldblooded carnivores of the sam size in order to maintain their constant body temperatures. Consequently, when predators and pre are about the same size, a community of coldblooded animals will include relatively more predator (since each one needs to eat so muc less) than a community of warmblooded animals. The ratio of predators to prey may reach 40 percent i coldblooded communities; it doe not exceed 3 percent in warmblooded communities. Predators ar rare in dinosaur communities; thei relative abundance matches our expectation for modern communitie of warmblooded animals.

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4. Dinosaur anatomy. Dinosaurs are usually depicted as slow, lumbering beasts, but newer reconstructions indicate that many large dinosaurs resembled modern running mammals in locomotor anatomy and the proportions of their limbs.

But how can we view feathers as an inheritance from dinosaurs; surely no *Brontosaurus* was ever invested like a peacock. For what did *Archaeopteryx* use its feathers? If for flight, then feathers may belong to birds alone; no one has ever postulated an airborne dinosaur (flying pterosaurs belong to a separate group). But Ostrom's anatomical reconstruction strongly suggests that *Archaeopteryx* could not fly; its feathered forearms are joined to its shoulder girdle in a manner quite inappropriate for flapping a wing. Ostrom suggests a dual function for feathers: insulation to protect a small warmblooded creature from heat loss and as a sort of basket trap to catch flying insects and other small prey in a fully enclosed embrace.

No theme has recycled through these columns more frequently than the effects of size. *Archaeopteryx* was a tiny animal, weighing less than a pound. It was a full foot shorter than the smallest dinosaur. Small creatures have a very high ratio of surface area to volume. Heat is generated by the body's volume and radiated out through its surface. Small warmblooded creatures have special problems in maintaining a constant body temperature since heat dissipates so quickly from their relatively enormous surface. Shrews, although insulated by a coat of hair, must eat nearly all the time to keep their internal fires burning. The ratio of surface to volume was so low in large dinosaurs that they could maintain constant temperatures without insulation. But as soon as any dinosaur or its descendant became very small, it would need insulation to remain warmblooded. We may view feathers as a primary adaptation for constant temperatures in small dinosaurs. Bakker suggests that many small coelurosaurs may have been feathered as well. (Very few fossils would preserve any feathers; *Archaeopteryx* is a great rarity of exquisite preservation.)

Feathers, evolved primarily for insulation, were soon exploited for another purpose in flight. Indeed, it is hard to imagine how feathers could have evolved if they never had a use apart from flight. The ancestors of birds were surely flightless, and feathers did not arise all at once and fully formed. Ho could natural selection build an adapt tion through several intermediate stag in ancestors that had no use for it? E postulating a primary function for ins lation, we may view feathers as a d vice for giving warmblooded dinosau an access to the ecological advantag of small size.

Ostrom's arguments for a descent birds from coelurosaurian dinosaurs d not depend upon the warmbloodedne of dinosaurs or the primary utility feathers as insulation. They are bas instead upon the classical methods comparative anatomy — detailed pa by-part similarity between bones and contention that such striking r semblance must reflect common d scent, not convergence. I believe th Ostrom's arguments will stand no ma ter how the hot debate about warr blooded dinosaurs eventually resolv itself.

But the descent of birds fro dinosaurs wins its fascination in t public eye only if birds inherited the primary adaptations of feathers a warmbloodedness directly fro dinosaurs. If birds developed the adaptations after they branched, th dinosaurs are perfectly good reptiles their physiology; they should be ke with turtles, lizards, and their kin in t class Reptilia. (I tend to be a tr ditionalist rather than a cladist in n taxonomic philosophy.) But dinosaurs really were warmbloode and if feathers were their way of r maining warmblooded at small size then birds inherited the basis of th success from dinosaurs. And dinosaurs were closer to birds than other reptiles in their physiology, th we have a classical structural argum — not just a genealogical claim — f the formal alliance of birds a dinosaurs in a new class, Dinosauri

Bakker and Galton write: "T avian radiation is an aerial exploitati of basic dinosaur physiology and str ture, much as the bat radiation is aerial exploitation of basic, primiti mammal physiology. Bats are not sep rated into an independent class mer because they fly. We believe that neit flight nor the species diversity of bi merits separation from dinosaurs o class level." Think of *Tyrannosaur* and thank the old terror as a represen tive of his group, when you split t wishbone later this month.

Biologist Stephen Jay Gould's m recent book is Ever Since Darwin: F flections in Natural History.

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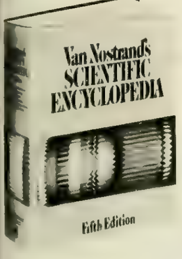

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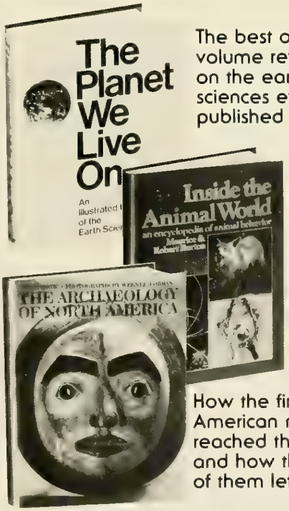
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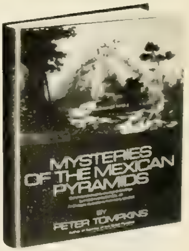

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by Alton A. Lindsey

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The historic weather-beaten cottage gradually revealed itself through the leafless trees as my walk down the lane neared an end. My long search for Pine Knot, the old presidential hideaway in western Virginia, forgotten except very locally, was over.

It was early 1976. The bare oak trees stood becalmed in the thin April sunshine, gathering from it the energy needed for their spring explosion. The same solitude beloved by Theodore and Edith Roosevelt was still there. How much does this modest house remember of its distinguished owners? It seemed unchanged since the day of TR's 1906 photograph, except that the cottontail rabbits he had bagged for the evening meal, which he would cook in one of the fireplaces within, were not now hanging on the west wall in the shade of the chimney. One felt that at any moment the brooding stillness might be broken by the creaking of saddle leather or by a rustling of fallen leaves from footfalls of a stocky figure strolling among the trees.

The president wrote his son Kermit in early June 1905, "Mother and I have just come from a lovely trip to Pine Knot. It is really a perfectly delightful little place; the nicest little place of its kind you can imagine. Mother is a great deal more pleased with it than any child with any toy I ever saw. . . ." The cottage and the surrounding fifteen wooded acres had been given her by longtime friends of her family, the Wilmers of adjacent Plain Dealing. TR hired Dick McDaniel to build two chimneys and fireplaces of native stone, so that a roaring fire at each end of the large downstairs room would keep the family warm on winter weekends. Later, another seventy-five acres were added and the family kept the whole ninety until 1941. The couple usually took breakfast on the porch to hear the morning bird chorus.

When John Burroughs spent four days at Pine Knot with the Roosevelts, he and TR identified seventy-five species of birds in the woods and fields. TR showed his friend two kinds new to Burroughs and learned two others from him. Oom John, as TR always addressed him, wrote after the president's death that the latter had known the warblers in the trees overhead during that spring migration as well as he did himself. TR was especially expert on bird songs and calls.

Unlike today's presidential retreat, Camp David, at Pine Knot both luxury and security were scarce. Roosevelt would not tolerate the presence of Secret Service people there. He had learned to take care of himself in the wild Dakotah Territory of the 1880s. He confided in Burroughs that he went armed and felt confident he could get the drop on any intruder. One night during a stroll, Burroughs heard something large rushing away from him through the woods. When he mentioned it to Edith Roosevelt the next morning, she whispered that it was doubtless one of the two agents who watched over the cottage secretly at night and hid in a nearby farmhouse in the daytime. Autumns, TR used to leave on wild turkey hunts as early as three in the morning and return after dark. Thus, the stage was set for a tragicomedy in which a president of the United States shoots his own protector by mistake but, fortunately, the curtain never rose.

Roosevelt's most memorable wildlife experience at Pine Knot was, unquestionably, one no longer possible for anyone. He sighted, and observed for some time, a flock of passenger pigeons already believed, even then, to be extinct in the wild. A few score of years earlier, it had been the most amazingly abundant of all North American birds, perhaps the most abundant in the world. Is TR's identification of the pigeons really credible? If so, was he the last person ever to see free passenger pigeons? These questions will be considered after we have seen what sort of a naturalist, ecologist, and ornithologist Theodore Roosevelt was. For his qualifications certainly bear upon the validity of his wild pigeon claim, included rather inconspicuously in his leading article "Small Country Neighbors," in *Scribner's Magazine* for October 1907.

While Roosevelt's achievements in conservation are well known, the background that made them possible is not. He was not only one of our very few presidents who had a thorough education in science but the only one formally trained in the environmental sciences. From boyhood on, he became, in turn, a taxidermist, traveler, historian, author, hunter, law student, politician, rancher, conservationist, soldier, statesman, and explorer. But he was a naturalist from first to last, an important fact that seems to have been largely forgotten. The first and last letters he wrote were about birds, he wrote many technical publications on nature, and naturalists of his time considered him one of their number. He took camping trips in national parks with Muir and Burroughs.

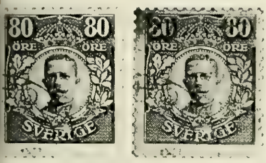
Theodore Roosevelt's parents lived in Manhattan, where Theodore was born in 1858. The father, a prosperous importer, was a founder of the American Museum of Natural History and assisted societies for the prevention of cruelty to animals. The boy's Uncle Robert was an attorney and writer of outdoor books, who predicted that many game species would suffer extinction unless protected by law. Young Theodore, however, first became a naturalist through his own efforts.

n Photographing the Invisible

o the naked eye, it was a Swedish 80-ore postage stamp. A rarity, and y valuable.

The camera, however, told quite other story. The stamp was a counfeit.

Faint traces of tampering that were lden to the naked eye were revealed the camera. Someone, somewhere, l ingeniously altered the stamp by emically removing a surprint. The mp was worthless.



To the naked eye (left), the stamp was genuine. To the camera (right), it was a counterfeit. Note the faint, dark traces of tampering now revealed in the upper section.

What manner of exotic camera is this that could "see" the invisible?

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I remember distinctly [TR wrote] the first day that I started my career as a zoologist. I was walking up Broadway, and as I passed the market . . . I suddenly saw a dead seal laid out on a slab of wood. That seal filled me with every possible feeling of romance and adventure. . . . I haunted the market day after day. I measured it [the seal] . . . and at once began to write a natural history of my own, on the strength of that seal. . . . I did get the seal's skull and with two of my cousins promptly started what we ambitiously called the "Roosevelt Museum of Natural History." My father and mother encouraged me warmly in this . . . When I was thirteen I was allowed to take lessons in taxidermy from a Mr. Bell . . . who had been a companion of Audubon's.

Theodore built up an outstanding collection of museum skins of birds, which probably surpassed that of any other youngster in the country. Latin names were used for his labels and notebook records. His preferred reading was on animals, starting with a tome of Livingstone's on Africa (where TR was to lead a year-long collecting expedition for the Smithsonian soon after leaving the White House). In 1871, the family visited the Adirondacks when the region was still primitive. Th lad kept a diary, not neglecting technical names of things he found there.

At fourteen, TR took his second tri across the Atlantic and visited Egyp and Palestine. The family took houseboat 1,200 miles on the Nile where Theodore did his first significan collecting and taking of detailed note on nearly two hundred specimens. H learned the birds so well that he coul name them on sight when he was nex on the Nile, thirty-seven years later.

Young Roosevelt entered Harvard i 1876. He majored in biology, fully intending to make science his life work Soon before graduating *magna cu laude,* he changed his career plans because biology was then dominated b the light microscope. "The sound revolt against superficiality had been carried to an extreme; thoroughness i minutiae had been erected into a fetish . . . I had no more desire or ability to b a microscopist and section-cutter tha to be a mathematician." His first writing to see print was an account o Adirondack birds seen on a trip with fellow student; his name first appeare

Cottage at Pine Knot, Virginia

Alton A. Lindse

the *Naturalists' Directory* in 1878. He ok occasional hunting trips in Maine ith woodsmen-guides whom he later nployed at his two ranches near Med-a, North Dakota.

His western activities from 1883 to 89 made into TR country forever the nd now in Theodore Roosevelt Na-onal Memorial Park, a major part of e Little Missouri National Grassland, hich includes the Badlands of North akota. Although he worked strenu-isly at ranching, the business aspect as less important to him than his out-oor observing, adventuring, hunting, d writing. He often said later that nch life had been the making of him. e wrote there his splendid trilogy of oks on his western life and part of his ur-volume history on the winning of e west. The Old West still lives in any of the thirty-eight books he pro-iced. This scholarly output should ve corrected the popular image of a litician crashing about like a bull oose while flashing a toothy grin. For s reputation as a man of action was a lf-truth; he was equally a man of in-llect.

The three intellectuals who have oc-pied the White House were Jeffer-n, Theodore Roosevelt, and Wilson, it TR had more humor and warmth an the other two combined. His eakness as an intellectual was that he d no weak opinions. Nevertheless, dividual aggressiveness has seldom en better directed to the common od, for progress in conservation and cial reform do not come about from e bland leading the bland. Memo-ble slogans and metaphors came from s wilderness experience: the Bull oose Party, the west African hunting overb, "Speak softly and carry a big ck; you will go far," and "The vote is e a rifle; its usefulness depends on the aracter of the user."

The five national parks, sixteen na-nal monuments, and many national rests and game preserves established ring his tenure endear TR to modern vironmentalists. For the parks, he d not follow the idea of high-use con-rvation, more properly espoused for rest Service operations by his utenant Gifford Pinchot. Roosevelt's ea was more subtle—to preserve the ry highest-quality areas of each type th a minimum of development, and at directed toward esthetic, scientific, d natural outdoor recreational use ly. He stated, "Nothing is more prac-al in the long run than the preserva-n of beauty."

Those claiming today that TR was

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not a "preservationist" should review the history of Grand Canyon National Park. In 1903 when this area was vulnerable as a mere game refuge, he took long horseback rides in its rimland country and must have decided then to make it a national monument; this he could do without the approval of Congress. Then he made a speech that was far more preservationist than the way the canyon was eventually handled, and while it antagonized the local audience, it delights modern preservationists.

> In the Grand Canyon, Arizona has a natural wonder which, so far as I know, is in kind absolutely unparalleled throughout the rest of the world. I want to ask you to do one thing in connection with it in your own interest and in the interest of the country—keep this great wonder of nature as it is. I hope you will not have a building of any kind, not a summer cottage, a hotel or anything else, to mar the wonderful grandeur, the sublimity, the great loneliness and beauty of the Canyon. You cannot improve it. The ages have been at work on it, and man can only mar it.

The great American presidents were those who saw their responsibilities to the future and acted on them. We hear pious talk deploring TR's "big stick" methods, but in truth he practiced an enlightened ethic precisely where it is most important and most difficult to do so—toward the rights and needs of unborn generations. The environmental movement he started and the living wildlands he set aside from ordinary exploitation commemorate TR more suitably than his visage on Mount Rushmore.

After birding with Roosevelt at the White House grounds, at Pine Knot, Yellowstone Park, and Sagamore Hill, John Burroughs wrote:

> I refer to his keenness and enthusiasm as a student of animal life, and his extraordinary powers of observation. He sees quickly and surely, not less so with the corporeal eye than with the mental. . . . The chief qualification of a born observer is an alert, sensitive, objective type of mind and this he has in preeminent degree. . . . His mind moves with wonderful celerity, and yet as an observer he is very cautious, jumps to no hasty conclusions.

Roosevelt's passenger pigeon sighting was first reported in letters to the U.S. Biological Survey and to John Burroughs. The readers of *Scribner's Magazine* learned about it five months later.

> On May 18th, 1907, I saw a small party of a dozen or so passenger pigeons, birds I had not seen for a quarter of a century and never expected to see again. I saw them two or three times flying hither and thither with great rapidity, and once they perched in a tall dead pine on the edge of an old field. They were unmistakable; yet the sight was so unexpected that I almost doubted my eyes, and welcomed a bit of corroborative evidence coming from Dick McDaniel, the colored foreman at Plain Dealing. Dick is a frequent companion of mine in rambles around the country, and he is an unusually close and accurate observer of birds, and of wild things generally.

Burroughs and Roosevelt together questioned McDaniel about all aspects of his sighting of about forty-five of the birds six days before TR's sighting. His observations agreed with the president's in every particular. McDaniel was familiar with passenger pigeons from his youth, but had always called them "wild carrier pigeons." Burroughs wrote at the time that, despite initial skepticism, he was now convinced that both men had seen passenger pigeons.

The only other sharp-tailed, dove-shaped bird that an ornithologist of TR's capabilities could conceivably have confused with the wild pigeon is the mourning dove. But the birds seen by both observers were decidedly larger than the familiar dove. The latter averages four and a half inches shorter than the wild pigeon. Wingspread, the distinction most apparent in flight, is 17 to 19 inches for the dove and 23 to 25.5 for the pigeon. Other evidence was the flocking behavior at that time of year, the characteristic circling behavior of wild pigeon flocks, the red breasts, very rapid flight, and lack of the whistling sound that marks mourning doves in flight.

In mourning doves, the pair-bond is strong in spring; the only possible flocking then would be by the young of the year, and these would not have had red breasts nor their full overall length. But pigeons spent the entire year in flocks, even in breeding. As a skilled wingshot, TR was better qualified than most ornithologists to judge the rapidity of flight, and as an expert in bird sounds he would surely have noticed the whistling noise if they had been doves.

Roosevelt could have gone back to Pine Knot for his shotgun to collect a bird for final confirmation, but he wrote, "Nothing could have persuaded me to shoot them. There were mourning doves in the field for me to compare them with, and I do not see how I could have been mistaken." This direct comparison with doves clinched the matter for the ornithologists at the American Museum of Natural History, and the accepted the record according to a lett written later by Robert Cushman Mu phy.

The last specimen authenticated as date of collection was a single bird sh in August 1906 in Fairfield Count Connecticut. A small flock captured 1878 had been established in the Ci cinnati zoo, and eventually produce Martha, the last individual of what w once the most abundant bird of Nor America. She died there in 1914 at ag 29, fifty-seven years after the Oh Legislature had declared, "Th passenger pigeon needs no protectio Wonderfully prolific. . . ."

Biologists scoffed at the plethora alleged sightings by farmers and hu ters, from about 1890 on, because s many laymen's reports were obvious based on mourning doves or on dista flocks of other birds, such as curlew No claims after TR's have been esta lished to the satisfaction of o nithologists. His dozen or so bir were, so far as science and history ca tell, the last free members of a specie a single flock of which the conservati ornithologist Alexander Wilson in 183 estimated to contain at lea 2,230,270,000 birds.

There is no indication that the pres dent tried to determine whether the ve few subsequent newspaper stories sightings by untrained observers we reliable. Neither did he push for th acceptance of his own sighting. But h never saw cause to doubt the accura of his identification of the Pine Kn flock, and allowed this incident to b reprinted in successive editions of h book *Outdoor Pastimes of an America Hunter.* He held to his origin statements, the mildest expression which was "I do not see how I cou have been mistaken."

Thus, Roosevelt probably nev realized that his sighting was the la time a trained, qualified naturalist ev saw wild passenger pigeons. Wheth he was actually the last human to s them will never be known. His dista for going back for his gun to valida the sighting beyond any possible que tion should not deprive this lifelo naturalist of the most dramatic bird re ord of the twentieth century.

Alton A. Lindsey, who received the En nent Ecologist Award last year, is pr fessor emeritus of botany at Purdue U versity and the author of numerous ar cles and books on plants, general ec ogy, and birds.

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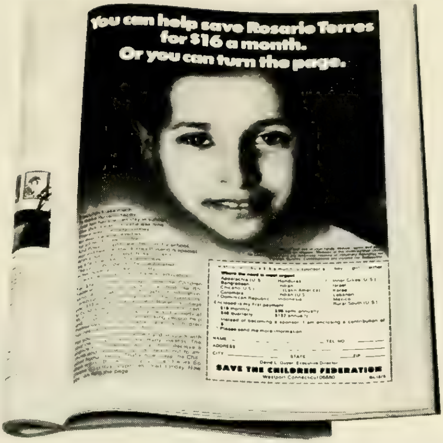
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Why Slugs Squabble

by C. David Rollo and William G. Wellington

Slugs prey on each other not only in courtship rituals but also in competition over vital food and shelter

Naked slugs lack the visual appeal of their decently clothed cousins, the snails. While slugs are denounced as slimy horrors to be squashed on sight, snails are depicted, in animated cartoons and children's books, as cheerful little wanderers. As *escargots*, snails appear on all the better menus. But no sane restaurateur would feature their shell-less relatives, even as *les limaces*.

Evidently, mollusks without shells are not acceptable to our fastidious eyes. Unfortunately, what is beneath our notice may not only continue to thrive but may also do much damage that escapes our notice. Slugs destroy an astonishing range of crops and ornamental plants in fields and gardens around the world. Most of us pay so little attention to the way slugs operate that we often blame garden insects for damage caused by slugs.

At first glance, slugs seem totally unsuited for life on dry land. These unprepossessing creatures have no direct control over the rate at which they lose water to the surrounding air. And they lose further vital water in the slime they trail wherever they travel: a slug moves by rippling its flat, muscular foot over a layer of mucus that it constantly secretes from a gland beneath its head.

A bag of cold water that cannot even move unless it leaks should not be able to survive outside a bog. But slugs not only survive in dry places; they have become highly successful terrestrial animals, despite the fact that direct sunlight can shrivel them as fast as the dawn crumpled Count Dracula.

A few slug species have avoided the uncertainties of life on dry land by opting for totally subterranean habitats, but most live above ground. They survive by restricting their mainly vegetarian foraging to the dampest times of day, when they can safely travel to normally intolerable places. They can climb tall trees, dropping back to the ground on threads of slime, like slippery caterpillars.

On damp, cloudy days, terrestrial slugs will forage in daylight, but dry weather restricts them to nocturnal forays. An extremely precise internal clock guides their nighttime travels, prompting them to emerge when the evening air has become damp enough for safe travel and insuring their return to shelter while the predawn environment is still tolerable.

Many slugs have a highly developed homing mechanism, mostly related to their sense of smell, that allows them to return repeatedly to particular crevices. A slug can find its own shelter from more than three feet away by following the odor of its droppings within the crevice and, perhaps, by the scent of a special slime it exudes while resting. Slime trails leading away from a slug's home may be quite devious, but homing trails are much straighter.

A slug that has strayed too far durin its nocturnal forays to be able to reac its home before daybreak may follo another slug's slime trail, much as motorist blinded by fog may keep a eye on another automobile's taillights This kind of tracking may lead a homeless slug to another slug's shelter, bu will not guarantee the occupant's hospitality. The resident may lash out violently and drive off the stray, which the must take its chances in the inimica light of dawn.

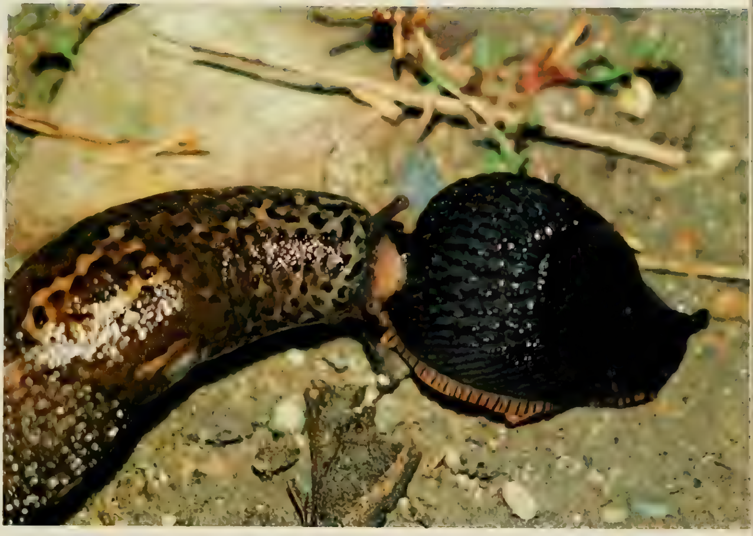
Previous descriptions of aggressiv behavior in slugs have been limited t ritual displays associated with thei mating. Both slugs and snails are hermaphroditic. Their mating is usuall preceded by elaborate courting ritual that supposedly reduce the chance o hybridization. During courtship, partners of most species circle each othe for long periods. At certain stages, th partners carry on bouts of ritualize lunging, biting, or sideswiping wit their tails. A few slugs and severa kinds of snails even produce calcareou

In a characteristic battle over food o shelter, a giant garden slug bites th flank of a smaller specimen, whic tries to defend itself by using it tail to sideswipe the attacke

William G. Wellingto

William G. Wellington

C. David Rollo



A native of the Pacific Northwest, the banana slug, left, lays eggs that are nearly ten millimeters in diameter. Although this giant slug can attain a length of more than twenty-five centimeters, it is no match for pugnacious Limax maximus, *a European species that is invading suburban forests. Above, a black garden slug contracts and rocks from side to side to fend off* L. maximus.

or chitinous "recognition darts," which they shoot — like slow-motion cupids — into their partners. Some species, such as the giant garden slug, *Limax maximus*, climb plants and launch themselves into the air, finally mating while entwined in supporting strands of mucus.

However bizarre the methods of consummation may be, the ritualized aggression that precedes it is frequently accompanied by an even more startling display of the huge sex organs with which many slugs are endowed. The sight of a courting pair of slugs majestically circling one another and ceremoniously rasping small patches of skin from each other's flanks while they solemnly wave their enormous penises overhead puts the most improbably athletic couples of Pompeii and Khajraho into a more appropriate and severely diminished perspective.

With so much ritualized aggression to study in these soft-shelled mollusks' courtship displays, malacologists have not noticed more mundane incidents. Apart from a few casual observations of occasional biting or even cannibalism among slugs artificially crowded into confined quarters, articles on terrestrial slugs do not mention or describe day-to-day aggression between individuals. We have found, however, that aggressive acts between slugs of the same or different species are common, and have important effects on their abundance and distribution.

Deliberate attacks or head-to-head combat occur most frequently near shelter or on food. Any attack includes a predictable sequence of stages. The aggressor first touches the other slug with its optic tentacles, then rapidly withdraws them and touches the victim with its mouth. The aggressor then draws its head partially under its mantle, lifts the forepart of its body off the ground like a snake about to strike, and suddenly lunges forward, slashing downward with wide-open mouth. A slug's mouth contains a ribbon of small, filelike teeth, the radula, over which a platelike chitinous jaw chops downward like a guillotine. When the aggressor bites down with its jaw, it also everts its radula so that its teeth scrape backward on its victim's hide.

The victim reacts in a variety of vays. Most often, it lifts its tail and ideswipes its attacker, then moves off it top speed. Some slugs, before they lee, exude a large puddle of thick nucus. The assailant, confusing the ictim's smell with the real thing, may inger and aim several strikes at this ouddle while the prey escapes relatively inharmed. But the assailant is not alvays fooled and may immediately oursue and repeatedly strike the victim, intil it is badly injured or killed or until t somehow manages to creep out of ange.

A slug struck on the front part of its ody will protect itself by instantly reracting its head beneath its mantle, vhich it flares outward with a flapping notion. Slapping its front end hard gainst the ground makes a slug's body nuch broader and flatter and therefore nuch harder to bite. Some species, uch as the gray garden slug, *Deroceras eticulatum*, are able to secrete a milky lime on the injured part. This slime is ighly repellent, even to slugs spoiling or a fight. The most aggressive species, *Limax maximus*, hastily retreats fter getting a mouthful, and tries to vipe off the slime on nearby objects.

Slugs' reactions in their intra- and nter-specific encounters include the ame defenses they use when attacked y predatory insects. In fact, these defenses are usually much more effective gainst insects than against other slugs. For example, the common black slug, *Irion ater*, contracts into a hemispherial shape when it is pricked by any harp point—a pin, the jaw of a slug, or he mandibles of a beetle. At such enounters, *A. ater* pulls its head under its nantle, humps its back, presses its nantle and the margins of its foot ightly against the ground, and rocks rom side to side. A slippery, rocking emisphere can resist the small manlibles of an attacking beetle, but is no lefense against the guillotine jaw of a large *Limax*. Attacked by *L. maximus*, *A. ater* quickly abandons its pose and tries to escape.

After launching themselves from a branch, two giant garden slugs of the species Limax maximus *mate in midair. They are supported by mucous strands, which can stretch for as much as forty-five centimeters.*

C. David Rollo

If set upon from the rear, another slug, *Prophysaon andersoni*, can shed the tip of its tail, the way some insects and lizards shed appendages under attack. We have not yet seen *Prophysaon* shed its tail when attacked by another slug, but it does so when defending itself from one predatory snail, *Haplotrema minimum*.

Slugs also drive off insect enemies by flaring their mantles and exuding copious amounts of slime, which fouls predators' legs and mouths. They may suffocate the larvae of sciomyzid flies by excreting mucus that clogs the squirming attackers' spiracles. *Deroceras reticulatum* uses its milky slime to repel carabid and staphylinid beetles, as well as other slugs.

After one or more of these initial reactions to attack, most slugs attempt to escape at top speed. If forced to flee from their own or other species, small slugs are not appreciably slower than their larger elders and thus are not inevitably doomed upon attack. Rather than retreating, some slugs will turn on their assailants. Slugs that fight may acquire dueling scars but rarely suffer as much as victims that are repeatedly bitten in one or two places on their flanks as they crawl away from persistent attackers. The most pugnacious slugs we encountered, *Limax maximus* and *Arion subfuscus*, can inflict lethal wounds during pursuit, and we suspect that some slugs found dying on sidewalks after sunrise are attack victims, not merely strays caught by the morning sun.

Slugs' aggressiveness is certainly a seasonal phenomenon in southwestern British Columbia, where we found that *L. maximus* and *A. subfuscus* were most pugnacious during July and August, normally the drier period of summer in the Pacific Northwest. Shelter is important to slugs at all seasons of the year, but refuges that are sufficiently damp may become scarce during summer heat or drought. Whenever suitable shelter is in short supply, homing behavior is more obvious: more slugs promptly occupy, stake out, and return to the best shelters — those that are moist and closest to food.

Since shelter is vital to a slug's survival, it is worth fighting for; and so as homing becomes more marked, aggression increases. In summer, *L. maximus* adults consistently drive other species and weaker individuals of their own kind out of shelters and away from food. They even disrupt mating by attacking the partners. Since other species of slugs begin to avoid shelters occupied by *Limax* adults, solitary *Limax* adults eventually occupy all shelters near the better sources of food. But as autumn approaches, *Limax* adults calm down considerably, and their aggressiveness disappears during the winter. In fact, in midwinter we often found large groups of adult and juvenile *L. maximus* sheltering together. These gatherings would have been impossible while the adults were still combative.

Although both adult and immature slugs home to shelter, the adults also require shelter for their eggs, whereas the juveniles only rest there. Thus, the juveniles do not become as firmly attached to one place as their elders and are not at all aggressive. As summer waxes, adults' homing and aggressive responses seem to strengthen: at their peak, adult slugs will force larger juveniles to leave home, harrying them out of their birthplaces and into new habitats.

We know that homing has been observed in some marine mollusks, notably in limpets and octopuses. We also know that truly predatory slugs and snails exist on land and in the sea, but these are carnivores that attack other kinds of animals more often than one another. Our discovery of seasonally varying aggression and its linkage with homing behavior in largely vegetarian terrestrial slugs presents a very different view of their ecology and population biology and provides another way to generally assess the importance of aggression and territoriality in the population dynamics of animals.

The effects of aggression and territoriality on the numbers and distribution of animals are still not well understood. Many birds and mammals that display conspicuous individual behavior move so freely, and over such large areas, that it becomes too difficult and too expensive to study their populations. But even the most active slug has a home range only a few yards square. Slug populations are much easier to observe, and so these pugnacious gastropods may provide fuller answers to some important ecological questions. ☐

The Gregarious but Contentious Walrus

Text and Photographs by Fred Bruemmer

Tightly jammed herds and tusk rattling are features of this huge marine mammal's way of life

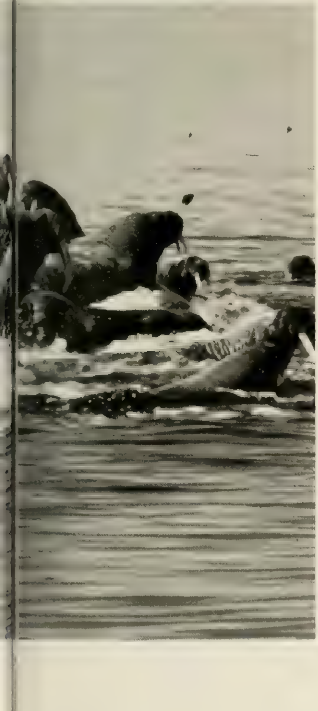
On a rare calm autumn day, delicate, chimelike tones, as of distant bells, drift gently over Round Island in Alaska's Bristol Bay. Incongruously, the melodious sounds emanate from some of the warty walrus bulls floating near the island. Just how they produce such sounds—heard most often among the ice floes of the Bering Sea during walrus courtship in late winter—is not known, but it is assumed that their large pharyngeal pouches act as resonators.

The thousands of walruses on and near Round Island in summer and fall are all males, and the sounds may be from a few young bulls "practicing" for the next breeding season. Some swim leisurely in groups of from five to fifty around the island, propelled by the rhythmic, alternate strokes of their large rear flippers. A few sleep vertically in the water near the island, buoyed, as by built-in Mae Wests, by their inflated pharyngeal pouches. But most lie on favorite island beaches in dense, malodorous congregations. They show a distinct preference for company and contact, yet at the same time they display a great deal of hierarchical hostility. Disputes are frequent and noisy.

As a rule, walruses seem highly gregarious. There is ample space c
Round Island, but nearly all the wa
ruses prefer to lie together, tightl
packed. After a storm, when most wa
ruses leave the wave-lashed beaches fo
a while, or when they have bee
panicked into the sea by a low-flyin
aircraft, they swim back and forth alor
the coast, loath to haul out on an empt
beach. Usually an old, massive bu
makes the first move. Wheezing ar
snorting, he laboriously hauls his tw
ton bulk onto the beach. He pauses fr
quently and appears apprehensive. A
this time, the warning cry of a gull ca
send him back into the sea. But once h
has found a congenial spot ar
stretched out, his presence acts as
magnet to other walruses. The small

ıes "walk" ashore, pivoting their hind ppers forward in a Chaplinesque addle, while the big bulls usually tch themselves forward in a sequence slow, massive heaves.

The behavior of latecomers seems depend on their social standing. naller animals come ashore quietly ıd try to insinuate themselves next to ready sleeping walruses. Big bulls lvance with much more assurance and ually crowd right in, jabbing those at are in the way with their tusks. A wer-ranking animal will try to move ıd make space, but a bull of equal anding is more likely to rear up with a ar, head thrown back, tusks held out rizontally. The two confront each her, feigning attacks or hacking downward and sideways with a speed surprising in animals so huge and bulky. Fights rarely last long. The weaker walrus backs off (in such a tightly packed group this is difficult and may result in a whole chain reaction of fighting), and the dominant one slumps down in the desired place. Severe injuries in these fights are infrequent. The walrus's skin, two inches thick, is extremely tough, but occasionally an animal bleeds from shoulder and neck gashes and twice I saw walruses that had lost an eye. Bulk, power, and tusk size seem to determine dominant status. Animals with short or broken tusks "regularly evince social inferiority to other walruses of the same size," biologist E. H. Miller observed during a study on the island.



For many hours, while the group establishes itself—usually with the most powerful animals near the center and subdominants on the periphery—there is constant jabbing and jostling, accompanied by a chorus of angry bellows and grunts. Once all are settled in an accepted order of precedence, they sleep soundly.

The herd consists mainly of adult bulls; most of them bear scars typical of the contests that take place between large males during the breeding season in February and March. After mating among the ice floes in the Bering Sea, the Round Island males begin their return journey to their traditional ugli, arriving there usually by May. ("Ugli" is the Eskimo term for a walrus hauling-out place; "uglit" is the plural.) The females with their young, the other adult bulls, and many immature males migrate northward to the rich shellfish banks of the Chukchi Sea. The Round Island bulls remain on the ugli through the summer and autumn; during this time their wounds heal and they molt. Bristol Bay is also apparently rich in shellfish, thereby providing the nonmigratory males with a dependable source of food.

Round Island, a part of the Walrus Islands State Game Sanctuary, is the site of one of the two remaining uglit on the American side of the Bering Sea and Bering Strait that are occupied on a predictable annual basis. The other ugli is on one of the Punuk Islands off the eastern end of Saint Lawrence Island. This hauling-out place is used mainly by adult females and immature individuals of both sexes during their southward autumn migration.

Once there were many such uglit on the Pribilof Islands (commercial hunters wiped out that walrus population by 1891), on Sledge Island near Nome, and on Besboro Island in Norton Sound. Of the thirty-three former uglit on the Siberian coast, where walruses once hauled out in groups ranging from a few hundred to many thousand, only two or three are still regularly occupied.

Unless they are exterminated or continuously disturbed, walruses will return to the same hauling-out place for centuries. Seahorse Point on Southampton Island in Hudson Bay was given its name in 1615 by the explorer William Baffin because he saw large numbers of walruses there. Walruses haul out at the same spot today.

In historic time, the southernmost walrus colonies were on Sable Island, one hundred miles east of Nova Scotia, on the latitude of Milan, Italy, and on the Magdalen Islands in the Gulf of Saint Lawrence. (During cold periods of the Pleistocene, walruses ranged even farther south and basked on the beaches of South Carolina and the Bay of Biscay.) In 1641, hunters from Boston obtained "four hundred pairs of seahorse teeth" on Sable Island, but by the end of the seventeenth century that colony had been exterminated. The much larger one on the Magdalen Islands vanished a century later; now only the many island names containing the word *echouerie,* the old French word for walrus hauling-out places (for example, "Plage de la Grande Echouerie"), recall their long-ago presence.

The herds of Atlantic walruses (*Odobenus rosmarus rosmarus*), once probably numbering in the hundreds of thousands, melted away under the incessant pressure of more than three centuries of commercial hunting. In the Spitsbergen archipelago, where the hunt started in 1604, the Norwegian biologist Thor Larsen has seen only five walruses in ten years of recent travel. (There are some indications, however, that walruses in this area may be on the increase.) On the little island of Moffen, situated off the northern end of West Spitsbergen, the preserved bones of slaughtered walruses are heaped in such masses that, from a distance, they look like snowdrifts. In the Canadian Arctic, when whale catches declined toward the end of the nineteenth century, whalers augmented cargos by methodically wiping out most of the accessible walrus colonies for their ivory, oil, and skins. There are now only about 10,000 walruses remaining in Canadian waters. Another 10,000 survive along the Greenland coasts, and an estimated 6,000 live in the seas north of Norway and the Soviet Union.

The commercial hunt of the Pacific walrus (*Odobenus rosmarus divergens*), whose original population is believed to have been about 200,000, began only in the nineteenth century, but was so enormous (200,000 were killed between 1860 and 1880 alone) that by the 1920s only about 40,000 were left. Now both populations are increasing: those of the Atlantic walrus slowly; those of the Pacific walrus, in recent decades, quite rapidly. The latter now numbers at least 140,000.

As their populations increase, the walruses establish new hauling-out places and attempt to resettle abandoned ones. In southern Hudson Bay, walruses now haul out on a new, little-known, but growing ugli off the Ontario coast near Cape Henrietta Maria. In the northern Bering Sea, they attempted a few years ago to haul out again on Sledge Island but were spotted by Eskimo and shot for food. (Walrus hunting on and near this island is now forbidden.) Walruses tried repeatedly to reestablish their ancient ugli on Big Diomede Island (Ostrov Ratmanova) in the Bering Strait, but were shot at and panicked away by Russian border guards stationed on the island.

The latest reports from Soviet biologists, however, indicate that many of the traditional walrus uglit on the Siberian coast are again being used, although as yet only on an irregular basis. Since about 1970 the ugli on Big Diomede Island has been used regularly during the autumn migration. On the American side, the uglit on Sledge and Besboro islands are now being used irregularly by walruses on their northward and southward migrations.

On Round Island, walrus numbers are also increasing. From a few individuals at the beginning of the century (in 1935, eight were spotted), they increased to about one thousand in 1953, three thousand in 1972, and more than five thousand in 1975.

With the onset of winter the water in Bristol Bay freezes over. Most of the members of the herd then swim out into the Bering Sea where they will spend the coldest months of the year with the females that have returned from the Chukchi Sea.

Walruses are good, though slow, swimmers. Their cruising speed rarely exceeds four to five miles per hour, but when chased by boats they can surge forward for a limited time at about twenty miles per hour. They are, perhaps, the least "marine" of the marine mammals. While elephant seals, sea lions, and fur seals haul ashore primarily to breed and molt, walruses spend much of their time resting on ice floes or on their traditional land uglit.

A few bulls, usually big ones, remain in the vicinity of the Chukchi Sea shellfish banks all winter. They can smash through ice up to eight inches thick by ramming it from below with their heavy, dense skulls. When the ice cover increases and thickens, they move to leads or to areas kept ice-free by strong currents and usually rest near the floe edge. They can endure severe cold and have been seen sleeping on ice when the temperature was −35°F with a strong wind blowing. Sheathed in a heavy skin and wrapped in a blubber blanket more than four inches thick on large bulls, they are well protected from the freezing air and the arctic water. The blubber is both insulation and energy reserve. At very cold temperatures the peripheral vascular system is cc stricted, and blood flow to blubb skin, and flippers is kept to an absolu minimum, thereby reducing loss body heat.

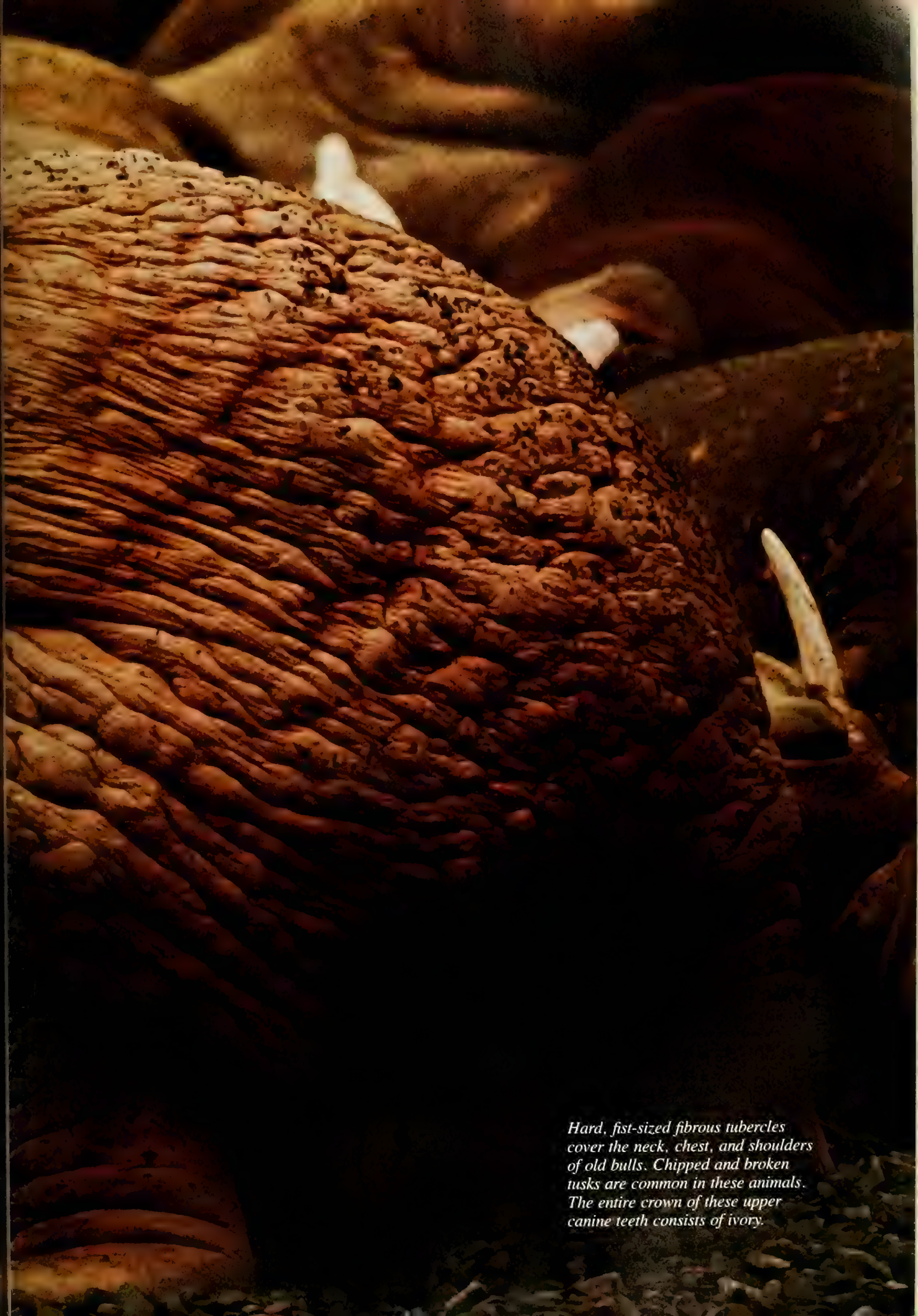
Heat loss may be further reduc when walruses huddle together in tig groups. This thigmotactic behavior h been explained by scientists Francis l Fay and Carleton Ray as an adaptati to preserve body heat. Whether sing or in groups, walruses in cold air al reduce surface exposure by assuming "fetal position"—head drawn in, ba arched, flippers pressed tightly again the body.

On warm summer days walrus have the opposite problem: they mu dissipate heat. They still huddle t gether on the beach although this mak heat dissipation more difficult, but the no longer curl up. On the contrar looking like bloated burghers on a h beach, they sprawl, often bell upward, flippers flung out, to expo the maximum amount of body surfa to the cooling air.

Walruses, covered by a short fur half-inch-long hairs, are normall madder brown. Molting, which usual takes place between May and Augus leaves them nearly hairless, and aft long immersion in the sea, they are peculiar bluish white or occasionally mottled gray. As they lie in the su their peripheral blood vessels dilat blood pulses through the vascular sy tem of blubber and skin, and the gradually change color—from whitis to a flush of pink to russet and roar When the temperature rises above 60 they become restless, sleep les soundly, and change position more fr quently; on the rare days when it rise above 65°, most seek relief in the cool ing sea.

During the late winter courtshi period, walruses emit a variety sounds, which may be used to establis underwater territories. While female and immature animals crowd the floes

Packed tusk by jowl, a herd of walru bulls sleeps on a traditional ugl on Round Island, off the coast o Alaska. A late-arriving bull ca set off a chain reaction of nois disputes as he jockeys for position



Hard, fist-sized fibrous tubercles cover the neck, chest, and shoulders of old bulls. Chipped and broken tusks are common in these animals. The entire crown of these upper canine teeth consists of ivory.

Heads thrown back and tusks held horizontally, walrus bulls threaten each other in a hierarchical dominance display. Actual fighting rarely causes serious wounds, but many bulls bear the scars of battle.

the larger bulls patrol the water around them. The bulls emit the melodic bell sounds, click their teeth with such rapidity that the sound is like castanets being played, and whistle shrilly through puckered lips, usually just before diving. They rise abruptly near chosen floes, expelling air with such force that their snorts can be heard for a considerable distance.

In early spring, as the herds move slowly northward in the Bering Sea, walrus cows that mated the previous year give birth on the floes. The calves are about four feet long, the size of an adult ringed seal, and weigh about 120 pounds. They are covered with a coat of short, silvery gray hairs, which are exchanged for rusty brown ones after the postnatal molt at two months of age. Despite the calves' size and weight, Ray and Fay have pointed out that they have "less than half as much physical insulation [hair and blubber] as other arctic pinnipeds of comparable size." Calves on their own are cold and shiver violently in the arctic air.

But, barring disasters, walrus calves are rarely alone. The mother–calf bond is extremely strong; for about two years they are nearly inseparable. The calf suckles frequently and grows rapidly on its mother's rich milk, which contains about 35 percent butterfat and 12 percent protein. Within a year, the calf will be five feet long and weigh about 450 pounds.

In cold weather, the female hugs the calf to her chest, cradling it with her broad, two-foot-long front flippers to keep it warm. When swimming, the calf rides on its mother's neck, clasping her firmly with its rough-soled flippers. When danger threatens, the female sweeps her calf off the floe, holds it to her chest with her flippers, and dives. She defends it valiantly and, even when severely wounded, does not abandon it. The high-pitched, desperate barking of a frightened calf arouses not only its mother to furious protectiveness but also impels nearby walruses to rush to its defense. Thus, although the reproductive rate of walruses is low, with cows bearing calves only at two- to three-year intervals, calf survival, due to intense maternal protection, is high.

Apart from man, walruses have few enemies. Powerful, long-tusked, belligerent, and reacting with fury when threatened, walruses are formidable antagonists. A very hungry polar bea may try to kill a walrus calf, but it chances of success are slim since th calf's mother will rush to its defense According to some reports, kille whales kill walruses, but the Polar Eskimo of northwestern Greenland clair that, on the contrary, killer whales ar afraid of walruses and avoid all encounters. When a Polar Eskimo is hunting i his frail kayak and is surprised far fror shore by killer whales, he cups hi hands and bellows into the water, imitating the roar of an enraged walru bull. The sound travels far in water, an Eskimo hunters have told me that th killer whales promptly veer off.

The strong group cohesion of wal

ruses tends to increase losses when they re hunted by man. When a group is ttacked, rather than flee, the walruses mill in the water, bellowing with rage nd attempting to assist wounded individuals. They try to support animals hat have trouble swimming and appear o push severely injured companions as hey try to haul themselves onto a floe. et walruses on floes only a few undred yards away often pay little or o attention to the tremendous noise nd confusion of such encounters. emales and young bulls in particular re highly aggressive, frequently atcking the boats of hunters with their usks.

Northward migration from the inter feeding grounds in the Bering ea to the summer feeding grounds in the Chukchi Sea begins in April and continues until July—the pace determined by the rate of breakup of the pack ice. Animals swim considerable distances before hauling out on the ice to rest. Herds of females, calves, and immature walruses are now in the vanguard, pods of young bulls follow, and lagging far behind and traveling at a more leisurely pace come groups of large bulls. By June most of the walruses reach the Bering Strait, riding the floes swept northward through the strait by the strong current flowing from the Bering into the Chukchi Sea.

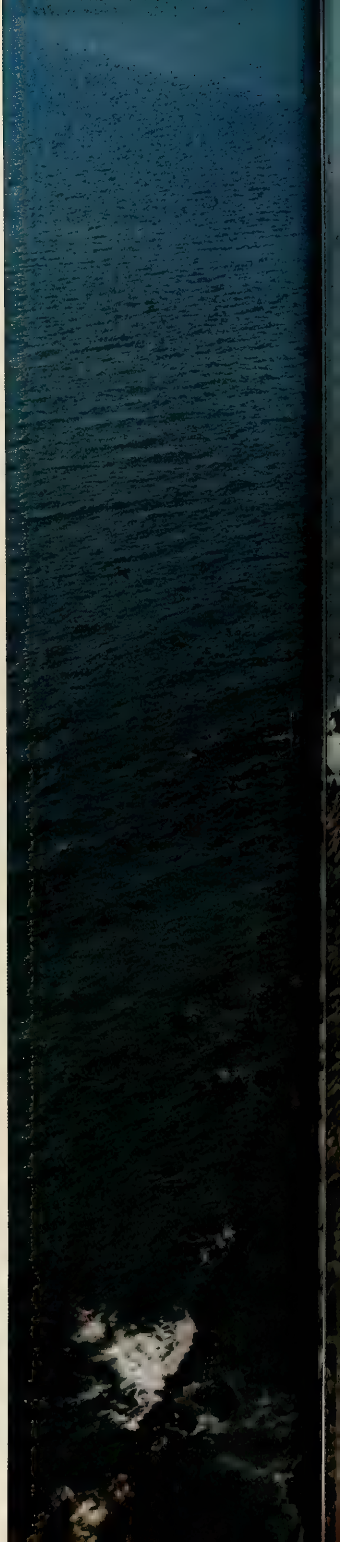
During summer, the herds disperse. Females and young seem to prefer the region near Wrangel Island; mature bulls are more common near the shellfish banks along the Siberian coast. Others spread eastward along the Alaskan coast, but only a few pass beyond Point Barrow into the Beaufort Sea.

Floating on floes above the shellfish grounds of the Chukchi Sea, the walruses dive, feed, fatten, and rest. Although they prefer shallower water, they can dive to a depth of about 300 feet and can remain submerged for nine to ten minutes. The assumption has been that walruses rake up shellfish with their tusks, crush them with their molars, swallow the mollusks, and spit out the shells. Scientists now speculate that the walrus dives to the sea bottom, roots in the muck like a pig searching for truffles, detects shellfish with its 400-odd, quill-like vibrissae set in highly innervated, sensitive mystacial pads, and sucks off the siphons and feet of cockles and clams with its strong, mobile lips.

In the Bering Strait region, they frequently feed on nearly fist-sized whelks that sit tightly in their whorled shells. The walruses apparently extract them easily; in their stomachs one finds no shells, only the fleshy bodies of the gastropods and a multitude of opercula. However it is done, a walrus is able to feed quickly and efficiently. Its full stomach weighs about 100 pounds and may contain the remains of 3,000 or more highly nutritive shellfish. Clams are their main and preferred food, but they also eat other benthic fauna — marine worms, sea cucumbers, shrimps, and marine snails.

While this is the diet of the vast majority of walruses, a few live on meat. These are the "killers," or "rogues," which figure prominently in

walrus bull bleeds from a head ound inflicted by another male. ecause a bull's skull is dense nough to enable the animal to mash through eight inches of ice, ost injuries are superficial.



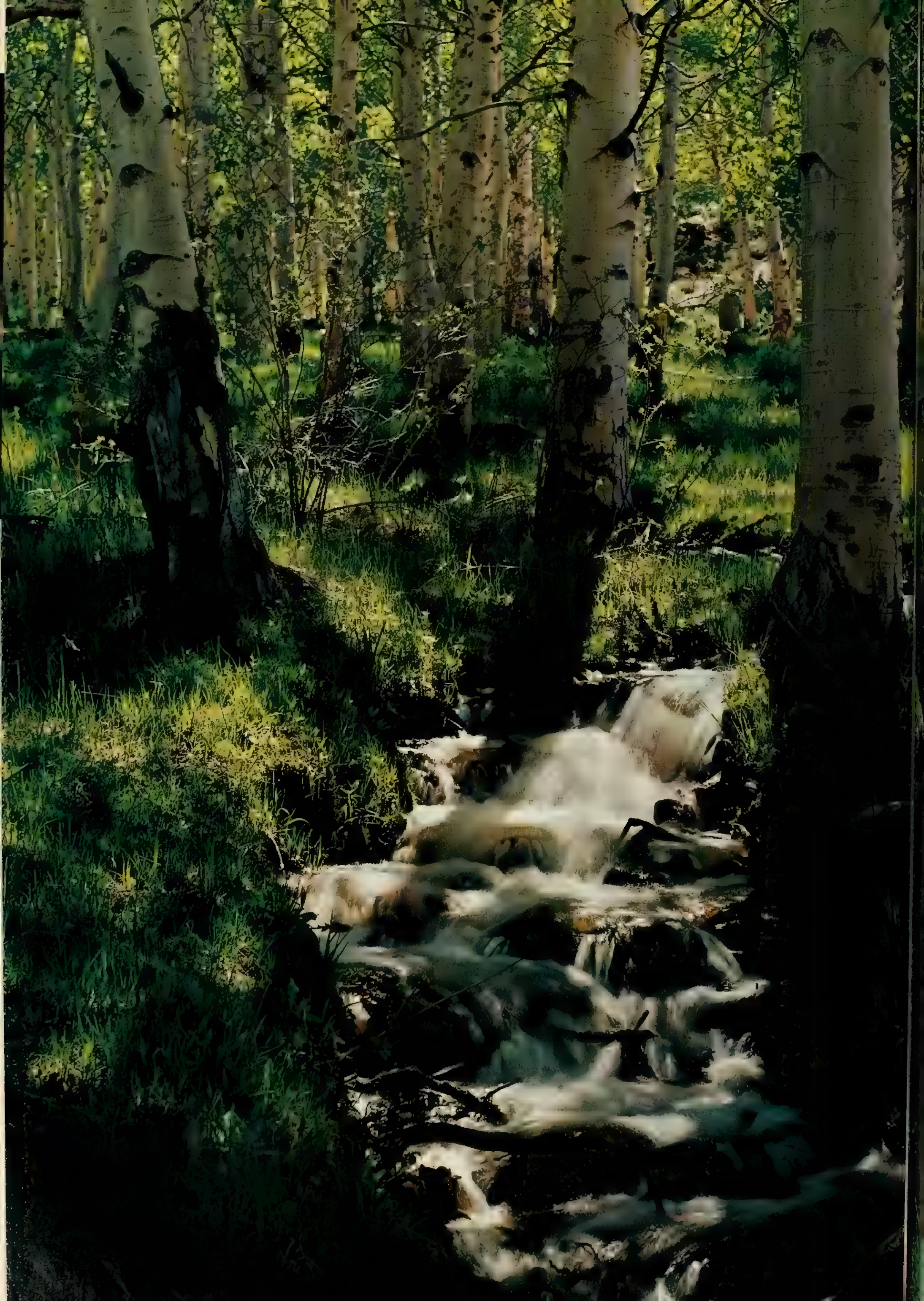
Using its broad, rough-soled flippers, a walrus heaves its massive bulk ashore. A herd ready to haul out on an empty beach is extremely cautious. Usually an old bull leads the way; not until he is settled will the others follow suit. During this time, the slightest disturbance can cause the animals to stampede back into the water. This ugli on Round Island is used by more than 5,000 walruses.

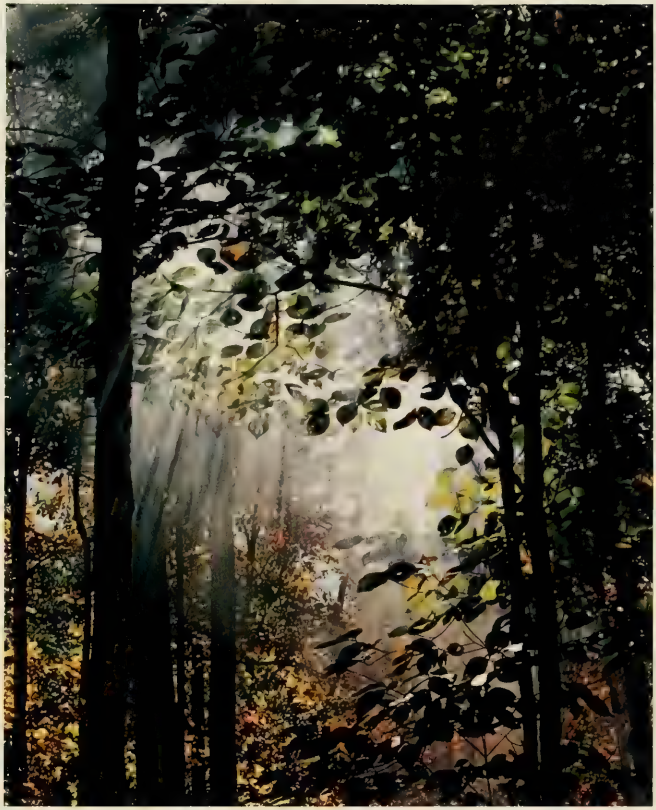
the lore of Eskimo from Siberia to Greenland. They are waifs, according to the Eskimo, animals that lost their mothers while still young. First they fed on carrion, then developed a taste for meat and began to kill and eat seals. The appearance of such rogues is distinctive. The shoulders and forelimbs appear unusually large and powerfully developed; chin, throat, chest, and tusks are amber colored by oxydized seal oil. Their tusks tend to be long, slender, and sharp. A rogue walrus, say the Eskimo, swims quietly up to a sleeping seal, enfolds it with its powerful front flippers, crushes it, rips the skin with its tusks, and sucks off the blubber and some of the meat. The livers of rogues, like those of the primarily blubber-eating polar bear, contain exceedingly high amounts of vitamin A. When eaten by man, the liver of such walruses can cause severe poisoning or even death due to hypervitaminosis. Rogue walruses, again like polar bears, are also likely to be infested with trichinae. In 1947 in Greenland, 300 people contracted trichinosis after eating such walrus meat and 33 died.

Although rogues are rare (about one in a thousand walruses, according to Fay), other pinnipeds are usually nervous in the vicinity of walruses. There is a small rookery of northern sea lions on Round Island, on the opposite side of the walrus beaches. Whenever walruses swim close past this rookery, the sea lions get the jitters. They roar loud warnings, follow the walruses' progress attentively, and relax only when they are well past their beach.

In late September, ice begins to form in the Chukchi Sea, the vast ice masses of the polar pack press southward, and the walruses begin their return migration to the Bering Sea, passing through the Bering Strait from mid-October to later December.

The exodus also begins on Round Island. A few walruses remain on or near the island all winter and they may be joined by some of the migrants from the north, but most disperse into the Bering Sea. Only when the ice vanishes in spring do those males that disdain to migrate to the Chukchi Sea return to the island to loaf on its beaches. □





S. J. Krasemann, Photo Researchers

The Fresh Air–Clean Water Exchange

F. Herbert Bormann and Gene E. Likens

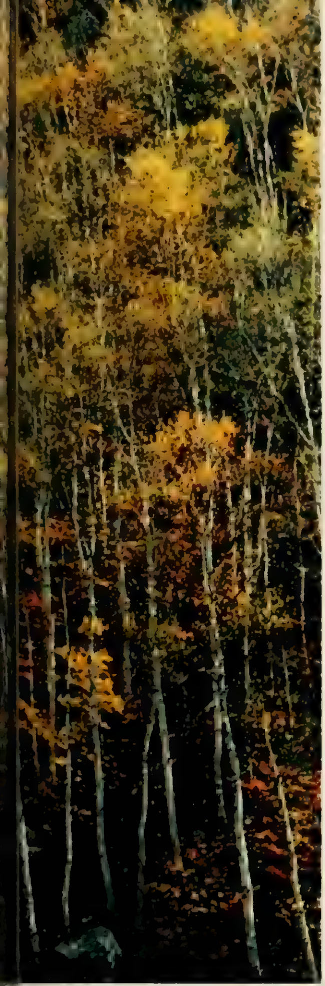
Forests remove pollutants from the environment at no cost to man. Solar energy powers the woodland cleansing machine

To the untrained eye, forests appear static; in reality, they are sites of intense activity. Each year, millions of gallons of precipitation, trillions of calories of energy, and vast tonnages of gases flow into each square mile of a forest. Thousands of plant, animal, and microbe species use these elements to live and reproduce, regulating the flow of water, energy, and nutrients through the ecosystem. Forests, with their complement of animal and plant species, provide immensely important benefits to humans—modifying streamflow and erosion, filtering the air and water that constantly flow through the landscape, and releasing sediment-free water to underground and surface water supplies. Stands of trees also modify

Shostal Associates

Michael Melford

Michael Melford



local climate by moderating temperatures and humidity. Through investigation of what enters and what leaves a forest ecosystem—and under what circumstances — a vivid, instructive picture emerges of the intense activity that goes on in a forest. A drainage stream, for example, can be viewed as analogous to the bloodstream of an animal. The stream can be used to keep tabs on the health of the forest.

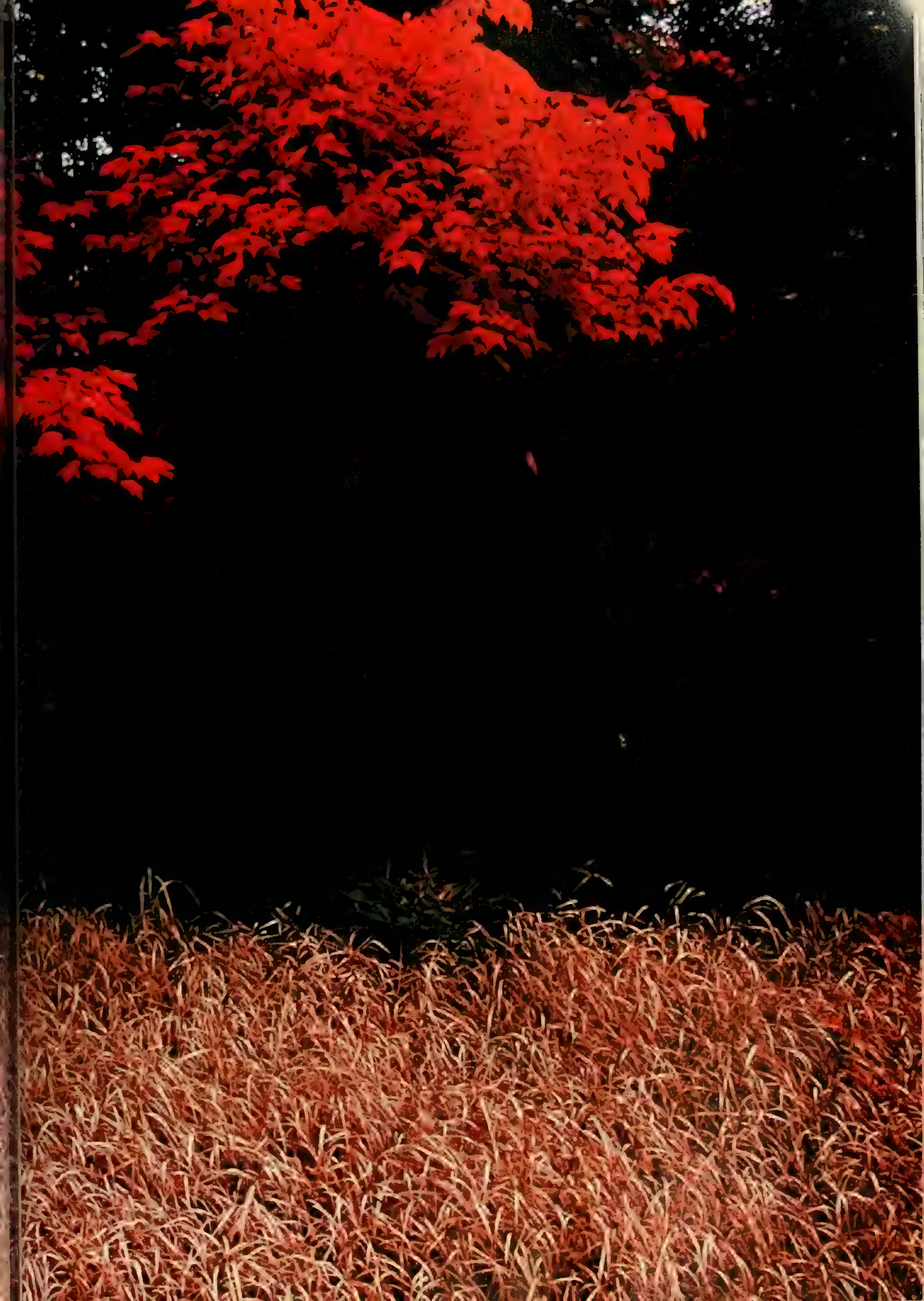
The areas we study are small (30 to 100 acres), heavily forested watersheds in the mountains of central New Hampshire. We measure the precipitation entering these watersheds and determine its chemical content. From this we can calculate the approximate amount of a specific nutrient that enters a particular watershed each year. Since the only way most nutrient substances can leave these watersheds is by being washed out by small streams, we measure the amount of streamflow and its chemical content and then calculate the pounds of each nutrient leaving the watershed during a year. From these data we construct nutrient budgets.

In a well-developed forest, large quantities of nutrients move about freely between vegetation and the soil, but very little is lost from the ecosystem in drainage water. We have measured small losses of calcium, sodium, and magnesium. At first glance it appears that the ecosystem is running downhill, but these losses are made up by the chemical breakdown of rock particles

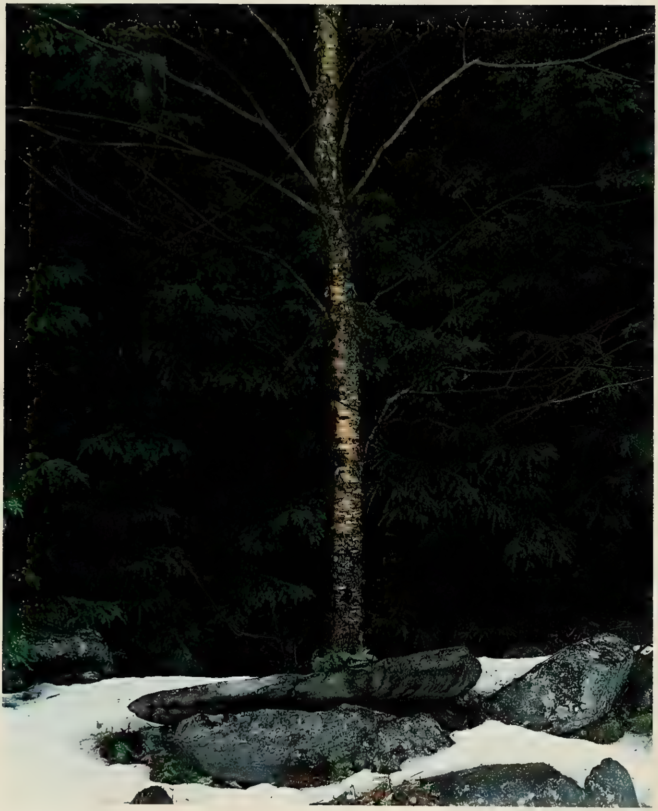
Paul von Baich

Michael Melford

Overleaf: Michael Melford



Michael Melford



through weathering. For example, only 2 percent of the calcium contained in, and circulating between, plants and soil leaves the ecosystem in stream water each year and that amount is replaced by the weathering of rock.

We had assumed that since streamflow is very low in summer, owing to water evaporation through plant leaves, but very high during spring snowmelt, concentrations of dissolved nutrients in the stream water draining from the watersheds would be high in summer and low in spring. Instead, nutrient concentrations remained about the same. This finding revealed a most important principle: a forest regulates the chemical quality of water percolating through it into streams or underground.

The qualities of mature forest soil are often the result of developmental processes occurring over hundreds or even thousands of years. Weathering, decay, and animal activity build up organic matter, silt, and clay, which contain the stores of nutrients necessary for plant growth. These are concentrated in the upper foot or two of most soils. Bulldozing and blacktopping destroy or disrupt nutrient cycles and thereby diminish the filtration capacity of the land.

Forest and other wildland soils are important filtration systems between polluted rainfall and human water supplies (streams and groundwater). We have discovered two important functions of the forest ecosystem in this regard. Measurements over a ten-year period indicate that the amount of nitrate (a naturally occurring compound of nitrogen that is also one of the end products of automobile exhaust) is increasing in rainfall. The addition of nitrate to streams and lakes can contribute to their eutrophication or to the accelerated growth of certain organisms with a consequent loss of water quality. Our

Peter Miller, Photo Researchers

Michael Melford

nutrient budget data show, however, that most nitrate is being held within the forest ecosystem and is not reaching surface and groundwater supplies. Rainfall is also becoming more acid as a result of the increasing use of fossil fuels, which introduce sulfur and nitrogen pollutants into the atmosphere. Over all of the northeastern United States, rainfall is now largely a mixture of water and sulfuric and nitric acids. This condition may worsen as the nation responds to the energy crisis by relaxing air-pollution standards, but our data indicate that the forest ecosystem removes much of the acid from rainwater; consequently, the stream water draining from the watersheds we studied is about thirty times less acid than rainwater.

Natural soils also remove a wide array of other pollutants from precipitation filtering through the soil, including dissolved heavy metals such as lead, zinc, nickel, copper, and manganese, some radioactive isotopes, and pesticides such as DDT. For example, some of the rain falling on New Hampshire forests exceeds national health standards for the lead content of drinking water, yet stream waters flowing from these forests have extraordinarily low lead contents.

Soil and forest vegetation also remove a variety of particulate and gaseous pollutants from the air. As wind passes through the trees, very fine particles of certain pollutants stick to leaves and branches, and gases, such as ammonia, sulfur dioxide, ozone, chlorine, and hydrogen fluoride, ar absorbed and chemically detoxified. Sulfur budgets we constructed sugges that vegetation may be especially efficient in removing this element from th ambient air. Recently, we have show through laboratory experiments that th microorganisms in forest soil have phenomenal capacity for absorbin carbon monoxide, a common pollutant from the air and biochemically converting it to harmless carbon dioxide. These experiments show that forest can improve the quality of air for humans. This, like water filtration, i done at no cost to man. Solar energ powers these processes.

A word of caution is necessary, however: the air and water filtration capacity of forest ecosystems is not un

An average of a million gallons of rainwater fall on each acre of land along the eastern seaboard of the United States. Rainfall, particularly over the northeastern states, is loaded with a mixture of nitric and sulfuric acids and carries high concentrations of such dissolved heavy metals as lead, nickel, and copper.

Ammonia, sulfur dioxide, ozone, carbon monoxide, chlorine, and other gases, along with particulate pollutants, flow into forests that are downwind from industrial operations and urbanized areas.

Very fine particles of some airborne pollutants adhere to the leaves and branches of trees. Quantities of many gaseous pollutants are absorbed and chemically detoxified by the trees and other plants. Most pollutants that enter the forest ecosystem eventually reach the ground where they are either bound up in the soil, chemically altered by microorganisms, or become nutrients for the trees.

mited. Forest vegetation and soils can bsorb and tolerate a modest amount of ollution and continue to function more r less normally for a period of time. Eventually, however, they will come nto equilibrium with pollution loads nd lose their storage function or pollution-induced damage may drastically lter the ecosystem.

Dramatic examples may be seen near eavily polluted industrial areas such as Ducktown, Tennessee; Palmerton, Pennsylvania; Magna, Utah; and Sudbury, Ontario, where pollution from melting plants has devastated natural cosystems and biological regulation nd cleansing of air and water flows has been essentially lost. Early symptoms of forest ecosystem destruction resulting from widespread automobile-caused air pollution are evident over thousands of square miles in the Los Angeles basin where, high in the surrounding mountains, millions of trees are dead or dying. A forest ecosystem should be seen, not as a license for additional pollution, but rather as a natural sponge with finite capacity.

An average of approximately one million gallons of water fall each year on each acre along the Atlantic seaboard. Yet this water's huge potential to wear away the land and to pollute surface water supplies with sediments is rarely realized because forests strongly control the erosive capacity of falling and flowing water. This regulation of the erosion cycle by vegetation is one of the keys to maintaining quality water supplies and healthy streams and lakes.

Our data from New Hampshire show that even though the forests we studied occur on steep slopes, each year they lose, on the average, only a few tons of eroded material per square mile. Studies from other areas suggest that rates of erosion for a variety of eastern deciduous forests are equally low. As a result of this regulation of erosion, water flowing to streams and groundwater from forested or other well-vegetated land is virtually sediment free and can be used by man with minimum treatment costs.

The enormous stabilizing force of forest ecosystems is best seen when contrasted with areas undergoing urbanization, where poor planning — usually combined with careless construction techniques — commonly produces erosion rates several thousand times greater than those for a well-developed forest. A rate of 140,000 tons of eroded material per square mile per year was reported from one construction site near Baltimore.

Massive erosion of upland construction sites results in serious degradation of aquatic ecosystems — streams, lakes, reservoirs, and estuaries. Sediments derived from erosion can change the physical character of stream channels, causing changes in bottom deposits, erosion of channel banks, obstruction of flow, and increased flooding. Sedimentation can fill natural ponds and reservoirs. Finer sediments reduce water quality, adversely affecting public and industrial water supplies and recreational uses. Turbid water, another result of increased erosion, reduces light penetration into water. This, in turn, reduces plant photosynthesis and may lower dissolved oxygen supplies, leading to changes in the natural flora and fauna. Coupled with these effects is the possibility that pollutants normally filtered out by soil and vegetation might find their way directly into human water (and air) supplies.

In areas moving toward urbanization, little thought is given to the natural functions of vegetation; the useful work of nature is totally undervalued or ignored. The urbanizing region is not seen as a highly interactive mosaic of natural and developed land with some optimal proportion necessary for a quality urban life. Powerful, but one-sided, arguments for profit, growth, and favorable tax rates generally outweigh arguments for leaving land in a natural state. The resultant proportions and distribution of natural and developed land are therefore artifacts of the marketplace.

What are the optimum proportions of developed and natural land? A study carried out in Georgia has estimated that two and a half acres of agricultural land, two acres of natural land, and half an acre of residential-industrial land are needed for each citizen. Obviously, optimum proportions are debatable and will vary according to local conditions, but it would seem prudent to maintain natural vegetation on all lands where the environmental costs of construction are especially high. These would include flood plains, wetlands, steep slopes, and areas with thin soils, erodible soils, or poor drainage.

When land is overdeveloped, the functions of natural systems have to be replaced with costly, fuel-consuming, technological substitutes. Larger and more elaborate sewage-disposal and water-treatment plants are needed. Air conditioning and filtration become a necessity rather than a luxury. Streams must be piped, channels dredged, and flood controls installed. Man-made facilities must substitute for natural recreation areas. The additional facilities necessitated by poor planning represent a huge and unnecessary expense to the tax-paying citizen.

Although arguments for the preservation of natural land in regions undergoing development are most often based on the need for recreation areas, wildlife preserves, and parks, a more basic argument exists, namely, the biologic and economic health of man. ☐

Air passing out of the forest ecosystem is considerably cleaner and more temperate than the air entering. Streams passing hrough forests carry less ediments and have a higher hemical quality. Trees and other vegetation also reduce looding and erosion downstream by regulating water flow. The entire system is powered by solar energy.

Fecund Mouflon

Text and Photographs by Raul Valdez and Leticia V. Alamia

High reproductivity is a key to the success of these Asian wild sheep

Sheep are among the most common large wild animals in Asia. They have survived despite constant hunting pressure and the extensive environmental impact of humans, who for millennia have occupied much of the wild sheep's range. Other animals on the Asian continent have suffered disastrous consequences, so the survival of wild sheep is a testament to their adaptability. Wild sheep in North America, with a shorter history of exposure to humans, have not fared nearly as well.

Based on body form and habitat preferences, wild sheep in Asia are divided into three basic species: Asiatic mouflon, argali, and Siberian bighorn. Mouflon, which we studied in Iran, also live in many areas of Turkey, Iraq, and Oman, and range into Soviet Turkmenistan, through Afghanistan, Pakistan, and northern India. (Another species of mouflon occurs in Europe.)

Mouflon differ, physically and ecologically, from their Siberian and North American relatives. Bighorn try to escape from their enemies by using their short, powerful legs and strong, muscular bodies to climb precipitous rock slopes where predators cannot follow. Mouflon, with their long, slender legs and graceful, supple bodies, flee from predators by running over the undulating, broken pastures they prefer.

Older Asiatic mouflon rams are more successful breeders than young males. Because of their dominance, they are able to segregate estrous females from a herd. Their refined courting technique also saves energy.

Mohammad Reza Shah National Park contains one of the most scenic wild sheep habitats in Asia. Situated in northeastern Iran, approximately forty miles from the Soviet border, it straddles both deciduous forests and upland sagebrush–bunch grass communities. Urial sheep — a subspecies or geographic race of mouflon — inhabit the gently rolling grassy steppes in the park. Lush growths of sagebrush, ephedra, wild alfalfa, festuca, and wheat grasses provide excellent forage. Dense stands of junipers cover the slopes of ravines; sheep avoid these as well as other forested areas.

The ten thousand urials in the park make up the most numerous and conspicuous population of large mammals in the park, but there are many others. Roe deer and red deer primarily inhabit the forest, although the latter occasionally wander into sheep habitat. Wild pigs prefer the humid forest floor where they root for vegetation and acorns, but during the spring and fall they move out onto the upland steppes to graze. Wild goats inhabit the precipitous, rocky slopes and ridges that sheep usually avoid.

Wolves and leopards are common in the park; both are major predators of ungulates. The leopard is a solitary predator, but Iranian wolves hunt much like their North American counterparts, usually moving in packs of three to six. Brown bears are basically forest dwellers, but to supplement their largely vegetarian diet, they occasionally wander into sheep habitat and prey on newborn lambs. Red foxes feed mainly on rodents, but they prey on wild sheep during the lambing season when the tiny newborn lambs can be easily overcome by a small predator.

Lambing in the park takes place in early May after a gestation period of 150 to 160 days. Ewes seek the best areas for lambing, mainly the lower, warmer altitudes that are not subject to chilly rains and snowstorms, which can occur on the uplands as late as May. Ewes also prefer warm, southern slopes associated with rocky, broken areas that afford cover and protection for the newborn lambs.

Prior to parturition, ewes live together in groups. Just before lambing, however, a pregnant female will leave the group and seek an isolated place in which to give birth to a single lamb or twins or, rarely, triplets. Lambs weigh about six to seven pounds at birth. Within a day they are able to follow the mother, albeit for short periods of time. When a potential predator is sensed, the lambs drop to the ground in an attempt to avoid detection. When they are four or five days old, lambs can keep up with their mother, and ewes and their lambs now rejoin the group.

Ewes spend a leisurely summer feeding on grasses and shrubs and nursing their young. Lambs are weaned at about four months of age, when they weigh about forty pounds. By October both the ewes and their offspring have grown their winter coats in preparation for winter.

During the spring, summer, and most of the fall, rams live in bands apart from the females. Rams frequent the higher, cooler elevations while the ewe–lamb groups remain at lower elevations. In October the rams begin to show interest in the ewes. In anticipation of the mating season (late November and early December), the rams come down to the areas preferred by ewes. By November the rams are mingling with the ewes. The larger rams begin to test ewes to see if they are in estrus, wandering from herd to herd in search of a receptive female.

Despite the seemingly random interaction of rams and ewes, there is a definite rank system involved in these encounters. Generally, the larger, older rams — at least five years of age — participate in mating. Whenever a younger male approaches a ewe, an older ram usually comes forward and drives him away with a threatening gesture, such as a twist of the head. Sometimes the older rams need only to present themselves in front of the younger rams in order to chase them off.

Older rams have a more refined courting technique than their younger competitors. Such a ram will approach a ewe in a low-stretch position, walking toward her from the rear with his head held at the level of her rump. He may occasionally rotate his head sharply right or left, with the chin toward the recipient, or touch the ewe with a quick kick of a foreleg. A courted ewe usually responds by squatting and urinating. The ram smells the urine, then performs a lip curl.

When a ewe comes into estrus, a large ram immediately segregates her from the main herd. The guarding ram prevents any others from bothering the ewe during this period of several days, especially younger rams who may attempt to steal her. Copulation takes place during this time of segregation.

Younger rams are less refined in their mating efforts. They are aggressive and bullying. Their approach to a female is not the slow, deliberate walk in a low-stretch position; instead, they run up behind a ewe, twisting and kicking, and succeed in making her scamper off. When a younger ram does steal an estrous ewe from an older male, his frenetic and inappropriate attempts to mate on the run only result in preventing the object of his attentions from feeding and resting. Such action lasts only until an older ram runs off the young suitor. The behavioral mechanisms through which older rams are dominant over younger ones may have evolved to protect the ewes from such unnecessary stress, conserving the energy of both sexes during the breeding season.

The rut peaks in early December, when snow usually blankets the summer pastures. By mid-December, the sheep begin to form large, mixed herds that concentrate in the lower valleys where they spend the winter. They do not leave these areas until the snow cover melts, which could be as late as March. At this time the rams and ewes again separate. The ewes remain in the lower valleys, at elevations of five to six thousand feet, in preparation for lambing, while the rams move back to the high pastures.

The ewe–lamb relationship of Asiatic mouflon shows a cursorial adaptation. North American bighorn often form nursery bands in which one adult female remains with a group of lambs while the rest of the ewes may wander several hundred yards away to feed. Such a situation has never been observed among wild sheep in Iran, where each lamb stays with its mother. In a species adapted to running from danger in gently rolling terrain, the lambs would be at a disadvantage in a nurser band. Confronted by predators, a grou of lambs could be easily scattered an separated from the attending ewe Mouflon lambs are therefore alway close to their mothers and ready to ru with them whenever alarmed. Nurser bands of bighorn are in less dange since they are seldom far from steep rocky terrain where the lambs can elud predators by climbing.

A juvenile mouflon frolics o
Kabudan Island in Lake Rizaiyeh
Iran. Running is the primary defens
of both mother and young. When
predator threatens, they fle
together over the rolling terrain

Among the major predators o mouflon in Iran are wolves, leopards and cheetahs. Leopards are restricted t mountain terrain; wolves are commo in most types of habitat, including mountains, plains, deserts and forests. In Asia, cheetahs occur in significan numbers only in northeastern Iran. They inhabit steppes and desert plains, where they rely on their speed to catch gazelles, and broken terrain to mountainous areas, where they feed on sheep. Leopards use their stealth to ambush or stalk sheep, then make a quick spurt to catch their prey. Wolves usually chase sheep until they can bring their quarry down with a biting attack.

In reproductive capacity, Asiatic sheep surpass North American bighorn. Bighorn give birth to one young per year; mouflon twin regularly. In studies conducted on one sheep population in Iran, more than 40 percent of the ewes were found to twin; among ewes four years and older, more than 50 percent twinned. This high reproductive potential can result in a rapid population increase after a period of decline.

Leopards are common in many of the mountainous areas of Iran that support wild sheep populations. Solitary hunters, leopards capture sheep by stalking or ambushing their fleet prey.

An excellent opportunity to study the population dynamics of wild sheep was afforded us on Kabudan Island, the largest of fifty-two islands in Lake Rizaiyeh in northwestern Iran. Kabudan covers an area of 7,600 acres and supports a population of Armenian sheep, another subspecies or race of mouflon. These animals were introduced from the mainland during the latter part of the nineteenth century, but hunting and competition from goats and domestic sheep that also grazed on the island limited the growth of the wild sheep population.

In 1967 the island was declared a wildlife refuge; with the removal of domestic animals by wildlife authorities and the curtailment of hunting, the wild sheep population quickly built up in numbers. The first count in 1969 revealed a population of 2,500 sheep. By 1970 there were an estimated 3,000 wild sheep on the island. That was more than the available vegetation could support. In succeeding winters the sheep suffered serious die-offs, and by 1972 the population numbered fewer than 1,000. It has remained at that level for the last three years. Nevertheless the quickness with which the population had previously built up is evidence of the high reproductivity of these sheep.

Wild sheep populations in Asia are parasitized with lungworms, liver flukes, and various other intestinal parasites. These parasites do not affect the sheep except in stressful conditions, such as overpopulation or severe winters. In these circumstances lambs usually suffer the highest mortality. During the first sheep population crash on Kabudan Island, more than 90 percent of the lamb crop died over the winter.

The introduction of domestic sheep and their diseases probably contributed to the decline of North American wild sheep populations. North American bighorn (Dall's sheep and the Rocky Mountain bighorn) have been separated from their Asiatic ancestors for thousands of years. During this separation, bighorn may have lost their immunity to some sheep diseases or simply did not evolve defenses against pathogens and parasites that appeared in Asiatic sheep after the two groups separated. Once the North American bighorn came into contact with domestic sheep, which were derived from Asiatic wild forms, they quickly succumbed to their diseases.

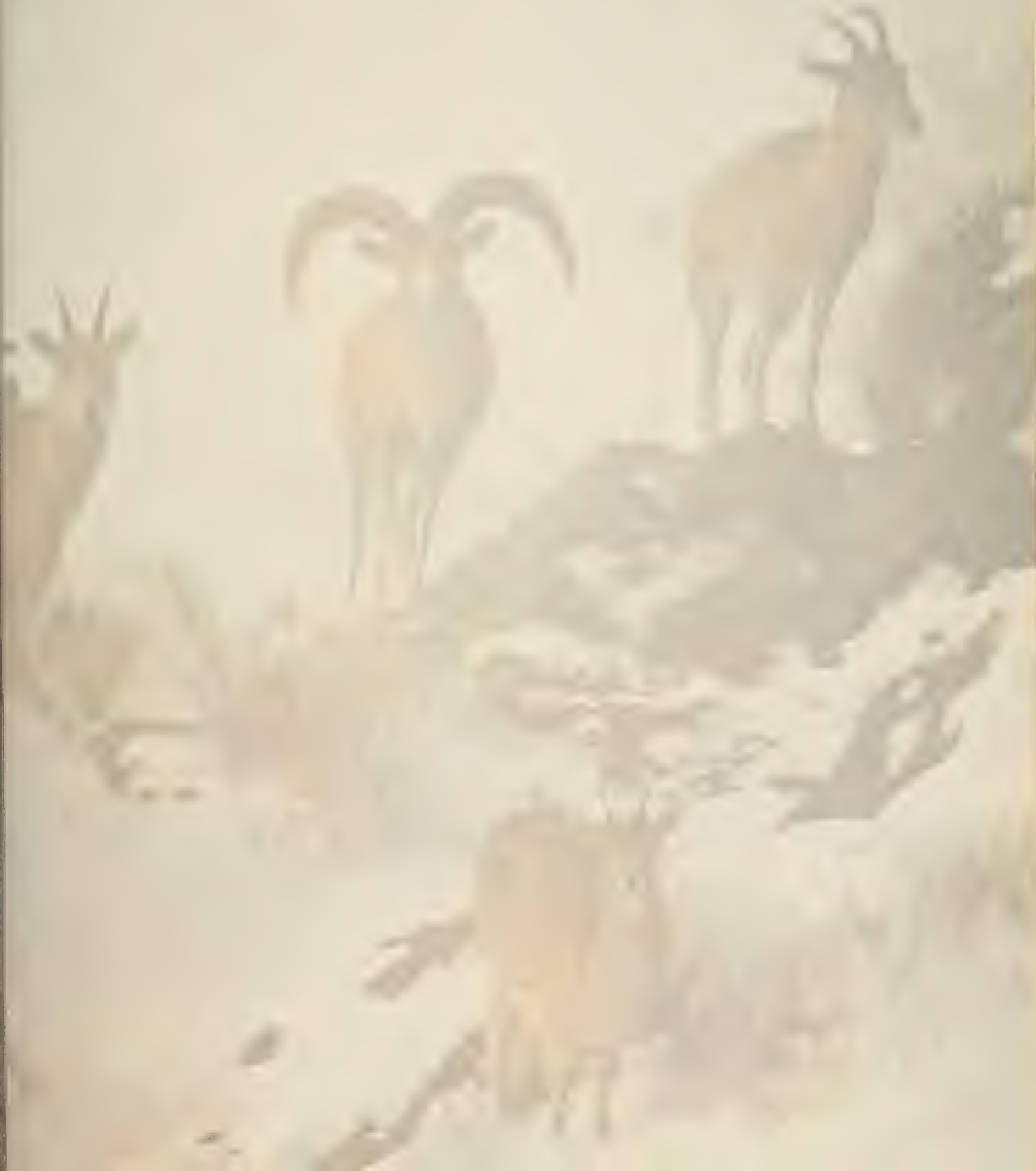
In Iran most wild sheep and domestic breeds have always lived in proximity and have coevolved some measure of tolerance to diseases and parasites.

In all of Asia, Iran probably supports the largest populations of wild sheep. There are several reasons for the paradoxical situation of the existence of large populations of wild sheep in a country where other large mammals have been decimated. One is that Iran is very large and, up to twenty years ago, had a relatively small population of about twenty million people. Wild sheep found refuge in the rugged mountain massifs and isolated, lightly populated areas. Another reason is enlightened wildlife conservation measures: Iran passed its first conservation law in 1956. Now the Iranian government supports a wildlife preserve system encompassing nineteen million acres and hundreds of game officers.

Many of these preserves contain excellent wild sheep habitat. Probably the most important reason for the large numbers of Asiatic wild sheep, however, is their tolerant and adaptive nature. Protection alone did not insure their survival. Despite many protective programs in the United States, wild sheep populations have failed to make a significant comeback. But because of their high reproductive capacity and ability to live in proximity to domestic breeds, Asiatic wild sheep can easily maintain their numbers or recover from heavy losses due to a catastrophe.

Asiatic wild sheep have a promising future. The esthetic and recreational values of wildlife are being recognized, and several other governments have now established wildlife populations. Hardy and tenacious, the sheep will thrive so long as they are not overhunted and provided their habitats are afforded some measure of protection. ☐

The rut is over by mid-December, and mixed herds of mouflon have moved to lower valleys to spend the winter. They will return to upland pastures in spring, after the snow cover has melted.



Street Dwellers

by Alan M. Beck and Philip Marden
photographs by Joan Roth

Little is known about New York City's durable street people, and they themselves do not explain their homeless lives

On a hot, humid Indian summer afternoon in New York City, the streets of Greenwich Village bustle with crowds. From sidewalk stands, long-haired craftsmen sell earrings and pottery to tourists in pantsuits and open-collared shirts; neighborhood couples hurry from butcher to baker to greengrocer, buying the weekend's groceries; teenagers carrying portable radios hang out in groups on the street corners. Traffic on the Avenue of the Americas (Sixth Avenue), one of New York's major thoroughfares, is heavy: many New Yorkers are escaping to the country for one last warm weekend. The traffic hardly slows as cars weave to avoid an elderly, unkempt woman who is slowly crossing in the middle of the block, seemingly oblivious to danger. She pushes a shopping cart overflowing with bags, bottles, pieces of cloth, broken appliances, and clothes. Despite the ninety degree heat, she is wearing three thin cloth coats and two sweaters. Eventually, she reaches the other side of the street, leaves her cart at the curb, and sits on the steps of a bank to rest. Some amazed passersby point her out to their companions; others recognize her and nod a greeting; some give her a coin or two, although she is not actively begging. Throughout the afternoon, she smokes the remains of cigarettes she has found. As dusk falls, she retrieves her cart and pushes it down the block. She checks a few trash cans, picks up food and a few objects that she wants, and puts them in her cart. Finally, she settles down in the doorway of a closed shop, where she will spend the night, shielded from the weather and from view.

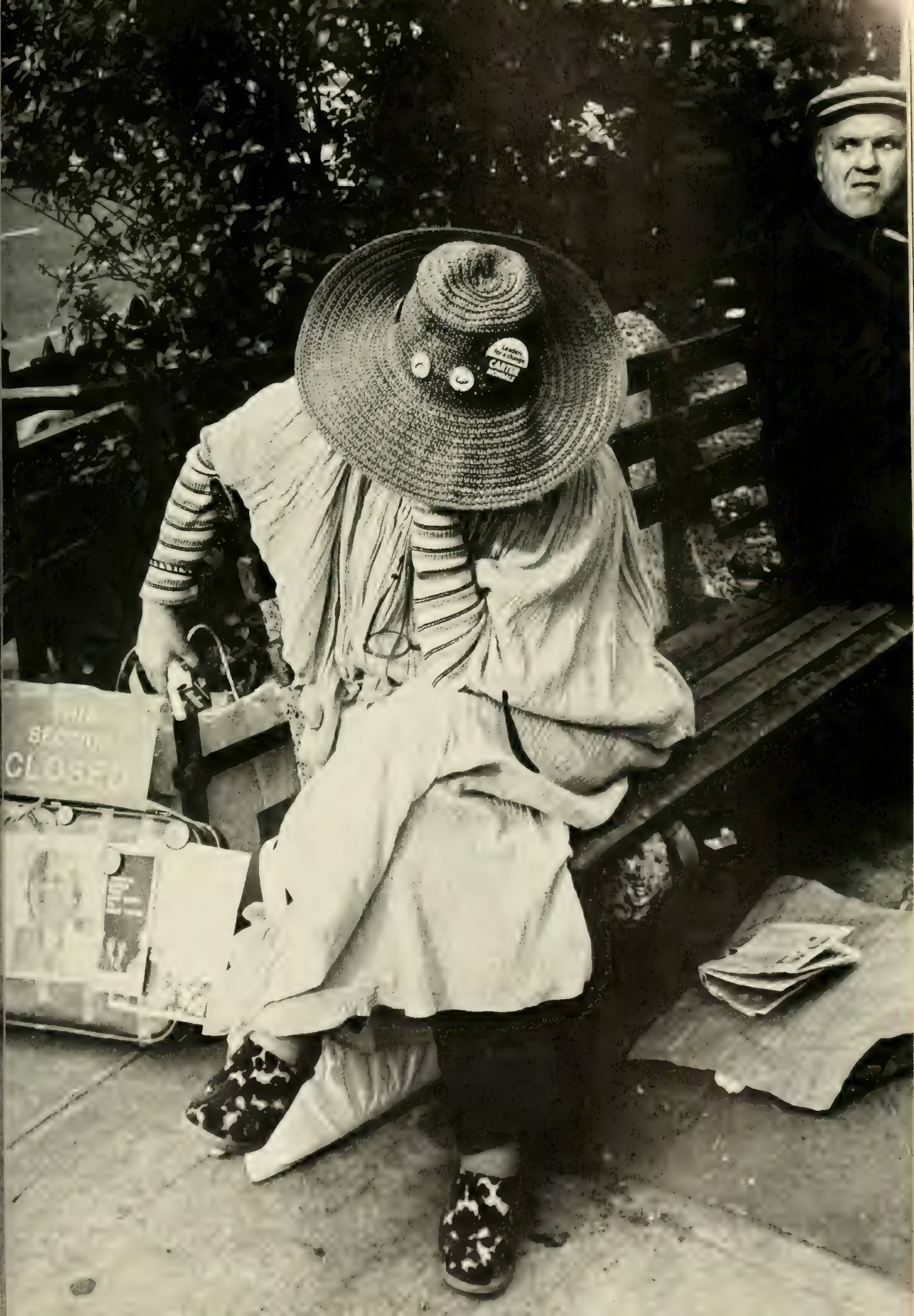
This is how Lea (a pseudonym) spends most of her days and nights. She is what New Yorkers call a "bag lady," although not all such people are women and not all carry everything they own in bags. Bag ladies are the most noticeable members of an urban subculture that spends most of its time on the streets. For people like Lea, at least for the time we knew them, the streets were their work, their recreation, and, in fact, their homes. Therefore, we called them "street dwellers."

Identifying an individual as a street dweller is a subjective and inexact task. We depended on physical appearance, behavior, and presence in the same general area over a period of days or weeks. People who carried excessive or inappropriate belongings for an extended period of time, who wore shabby or poorly fitting clothes, or who dressed unseasonably (many are probably anemic, and may wear several topcoats even during the summer) were considered candidates for study. So were people who spent an excessive amount of time in one place or a few places in the same area and people who rummaged through garbage, even if they were not encumbered by their belongings. Harry (another pseudonym), whom we always saw on the same block, told us that although he did spend all day and most nights on the street, he stored his possessions with a sympathetic merchant. Most street dwellers, however, had no storage and carried their possessions with them, usually in shopping bags, sometimes in canvas sacks, and less often in suitcases. One man's suitcase was so heavy that it had to be dragged along the ground, but most people packed for portability. Five of the people we studied used standard shopping carts, as Lea did, or supermarket baskets.

Most street dwellers' belongings are the staples of daily life — blankets, clothes, shoes, umbrellas, soap, pots, pans, and eating utensils. Like most of us, bag people are attached to some useless belongings — broken radios, scraps of fabric, toasters, electric clocks — even though they have no access to electricity. Lacking attics, basements, empty file boxes, and closets, street dwellers collect bags. We often observed people going through trash, scattering garbage on the street in order to retrieve empty bags. Perhaps they want to be prepared in case they find something of value.

Street dwellers are not found in all New York neighborhoods. They prefer moderately dense middle-income areas, such as Greenwich Village, perhaps because here they do not risk the reprisals they are subjected to by private homeowners in wealthier neighborhoods or the street violence of low-income areas. The Village is traditionally a bohemian community known for its young, integrated population, tolerant of nonconformist behavior and appearance. The geographic area, comprising large avenues and narrow back streets, is lined by small shops, restaurants, and for the most part, townhouses and low apartment buildings. The streets are never entirely empty. Some parts of the area have numerous coffeehouses, restaurants, and off-Broadway theaters, and are actually busier at night.

During our study, from October to December 1975, we observed street dwellers only in the Village's public places. At no time did we interfere with their activity, and we were prepared to abandon our observations if there was any evidence that we were doing so. In fact, however, subsequent interviews with some street dwellers revealed that


Leaders for a change
CARTER
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we were never even noticed. After completing field work, we interviewed officials at public shelters in the Village and several people who managed food programs used by street dwellers.

We also tape recorded interviews with the three most frequently observed street dwellers — two women, including Lea, and one man, Harry — about their background, way of life, and health. They were fully informed of our purpose and were paid for their services. But although their comments gave us some information about their present life-style, they provided little insight into our subjects' pasts or motivations: these people clearly did not have a totally accurate view of reality.

Lea could not precisely describe her background or how she came to live as she does, as indicated by our interviews.

> I was an actress; I had a daughter but lost track of her. I lost my glasses so I cannot write. I'm divorced. I was married to a bishop in the church. He had a head injury. I don't date. I used to write love letters. I'm going to cut it out, altogether. I also worked for the Treasury Department, but I haven't turned in anybody lately. You get $120 per year and more every time you turn in a bad person. I was after counterfeiters and people passing bad checks.

Years ago, Lea had a canary. Now, she has everything she owns with her.

Harry said he had been in the New York area for the last five years and on the streets for the last six months. He spent some time on the Bowery, but found "a better class of people up here." He comes from Santa Barbara, California, where he was a miner. "I did work in the garment center when I first got here." He has an illegitimate son — "a bastard, if you know what I mean." He does not date either.

> Date! With whom? On the Christian charity [handouts] I receive? I'm strictly a loner. I once got public assistance for a while, but then they reduced my budget. It went to arbitration and they reduced my budget even more. Now I won't ever go back. I am a Republican. Republicans have bank accounts, government issue [money]. Republicans are management; Democrats are labor. So, I am a Republican.

During our study, we identified fifty-three street dwellers: forty-one men and twelve women. We observed nine people on ten or more different days. From three to seven days we saw thirteen people, and saw thirty-one only once or twice. Each woman was observed for an average of nine days, and each man for an average of three and a half days. Four of the nine people we saw most frequently either appeared after we were well into the study or disappeared before it was completed. Often, people would be seen several days in succession, then disappear for some time. Since more than half were seen only briefly, we believe that some portion of the population takes to street dwelling only temporarily. Many social service workers we interviewed agreed that some street dwellers take on this role only during short periods of unemployment or between stints as temporary laborers, migrant workers, dishwashers. Others, like Lea, have been known and recognized as permanent neighborhood fixtures for years.

Determining age by appearance is never easy, and our age estimates had to be based on subjective impressions. We never saw street dwellers younger than twenty years of age, probably because in this country, very young vagrants are invariably picked up by police. More than 60 percent of our observed population was forty to sixty years old. About

0 percent were over sixty and 20 per-ent under forty. Our population aver-ged forty to fifty years old, and, in eneral, the women appeared older han the men.

While we observed them, street-dwelling men spent 60 percent of their ime sitting, women 80 percent. Since women moved around less (and we did ee individual women more often than nen), women may have smaller ranges han men. A New York City medical examiner confirmed our general observation that the majority of the street-dwelling population is male. He hought that the public assumes street people are female because "women tand out more. You expect to see male drunks and derelicts." We believe that women have smaller home ranges, and o local people see them more often and re more aware of them.

Because we wanted to draw an accu-ate picture of street dwellers' ecology, we tried to determine how they coped with their harsh environment — expo-sure to heat and cold, lack of food and shelter, illness. Male and female street dwellers reacted quite differently to emperature extremes. We observed significantly more men on the streets at higher temperatures (65° to 75°F) and significantly fewer at lower tempera-ures (30° to 45°). Men were more ac-ive as the temperature increased. In contrast, women were most active be-tween 45° and 55° and were least active between 65° and 75°. Assuming that a decline in the number of people visible on the streets meant that they were spending more time indoors or at least in a sheltered area, we found a lower tolerance for heat, but a higher tolerance for cold among women compared with men. Perhaps women were less willing to use the indoor alternatives, such as hotels or public shelters. (The neighborhood offers far fewer facilities for women.) Not surprisingly, the number of visible street people did not seem related to times of day: street dwellers do not "go home" at day's end. They seek shelter in response to weather, not the hour.

For street-dwelling people, finding places for shelter and for sleeping is not difficult. We saw them in doorways, telephone booths, restaurant entrances, subway stations. Father Lott, priest of a local church, told us that "street people generally come into church more to escape the cold than to worship." Harry said that some Village building superintendents allow street dwellers to rest in their basements, and that some token-booth attendants let them use subway stations. The New York subways are a vast complex of subterranean stations that are relatively warm and dry and may provide food and toilet facilities. Symbiotic relationships can develop between street dwellers and the rest of urban society. For example, Harry was permitted to sleep in a truck owned by a lighting-fixture store. Perhaps the merchant was simply magnanimous or he may have thought that his truck would be safer if someone was in it.

There are city-run shelters for both men and women near our study area. The men's shelter has room for several hundred men and places hundreds more in numerous low-cost, multiple-occupancy hotels, locally known as "flophouses." The women's shelter, on the other hand, can house fewer than fifty people and requires a higher order of personal hygiene standards than the men's shelters. During our study, no street dweller we observed appeared to be sleeping at these facilities. They usually slept in the open, in parks, or along busy streets. Three women spent nearly all their time within a few blocks of each other along a very busy stretch of Sixth Avenue. Two of them told us that they chose the area because they thought it was safe: in other parts of the city, they were harassed by storekeepers or assaulted by young hoodlums. Like the streets, Village parks are well populated all day long and therefore are relatively safe. Harry recalled that the police would chase him and fellow "parkmates" out of Washington Square Park when it closed. If he and the others returned a short time later, however, they could sleep in peace for the rest of the evening.

Both street dwellers and neighborhood people said that parks are more popular for sleeping during the warmer months of the year, while doorways, building halls, basements, subways, and public shelters are favored during colder periods. Lea preferred the outdoors all year round, insulating herself in winter with up to seven layers of newspaper under her coat. "I had eight coats but they stole them." (She never explained who "they" were.) In cold weather, Harry pursued a nomadic existence on the subway: he would ride

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for a while, get off to find something to eat in a station, then get on a train again. "I go to Washington [D.C.] for the winter. I take the dog [Greyhound bus]." In a heat wave, such as the one New York experienced last July, Lea took "sponge baths in the fountain." Harry said, "I take it slow."

Street dwellers get their food and water from a variety of sources: food programs, sympathetic pedestrians and merchants, and food refuse found on the streets and in trash cans. Some, including those we interviewed, were able to obtain enough money to purchase food.

Although some street dwellers actively solicit charity, others sit passively where they are well known and are often given money. A street dweller whose range is small becomes so much a part of the daily routine of the area that residents and local merchants provide food or money. With familiarity comes sympathy. Perhaps charity is encouraged by street dwellers' recognition of their patrons. The patron's act of charity is less anonymous and, therefore, more appreciated.

In Greenwich Village, many private, public, and religious organizations regularly provide free meals. These organizations include private, missionlike services supported by donations and small membership fees, men's and women's shelters maintained by the city, and church-sponsored food programs. Many of the street dwellers we observed used these services, but only sporadically. Frequenting the services probably requires more social interaction than some street dwellers desire. Basically loners, they are suspicious even of one another's company.

Some of our study population picked up discarded food and beverages from trash baskets in public parks and garbage cans on streets, but less frequently from restaurant and apartment garbage. We saw ten people eating food taken from garbage, and two ate such food almost exclusively. Most often, they found bread and rolls and such take-out items as rice and French fries and, less frequently, parts of sandwiches. For drinking, they relied on public water fountains, discarded cans and bottles of soda, and discarded liquor bottles. Unlike the derelicts found further south in the Bowery area, Village street dwellers were not often seen drinking alcoholic beverages.

To ascertain whether street dwellers really depended on discarded food and clothing, we compared their scavenging activities with times of garbage collection. There were three different garbage districts within our total study area. In two districts, collections were made on the same three days a week. After the day of collection, when discarded resources are at their lowest, we made 2.5 street dweller observations per hour. On other days, at least two days after a collection, we only counted 1.9 street dwellers per hour. Activity of these people was consistently greater after the garbage was removed and decreased as discarded resources began to accumulate until the next collection day. As resources became less available, street dwellers had to expend more effort. This relationship between collection day and scavenging was observed in all three collection districts, although street dwellers did not necessarily go outside an area after a collection day more than on any other day. Apparently, there is always enough food to be found in an area's garbage; after collection, however, street dwellers need more time to find it.

Because they rely on discarded food for nutrition, street dwellers risk all kinds of health problems. Discarded food does not necessarily guarantee a balanced diet — some street dwellers are overweight because discarded food is often starchy — and lack of refrigeration increases the chance of food poisoning. Going through garbage, street dwellers can incur nasty cuts from cans and broken bottles. And there are unexpected problems: once, while searching through trash cans, Lea was knocked down by a garbage truck. As scavengers, street dwellers constantly compete with bacteria, flies, rats, and dogs. The quality and amount of food varies, and often a street dweller can find nothing edible.

Far from being continually ill, however, street dwellers complained of few ailments. When asked about her health, Lea told us that the Treasury Department gave her a first-aid kit along with her gun and badge. She has had to hock the gun. Her major health problem is that her legs fall asleep. Father Lott, who runs one of the food and shelter programs that attract street dwellers, told us with some pride that during the flu season, street people showed up for services while many iddle-class parishoners were absent.

According to a medical examiner, ost people who die on the streets are coholics and heart-attack victims. xposure cases usually survive. For nalcoholics, the most common cause death is cerebral arteriosclerosis, the rdening of the brain's arteries that sults in senility. No one cares for nile street people.

If they do not want to be harassed, reet dwellers must avoid washing, inating, and defecating in public. here are, in fact, many public washoms in shelters, parks, subways, d public bathouses, as well as y showers in some Village hotels. ea routinely used subway pay-toilets wash herself and change her clothes, t she refused to remain in any of the urch shelters because they required r to change her clothes. Street vellers were observed both urinating d defecating somewhat discreetly in rks and on streets—as do people who e not street dwellers, especially at ght when the public toilets are locked.

Solidarity among street people is nknown. For the most part, they rarely teract with one another or with the neral public. Often, their contact with the public is limited to people who acknowledge them with a nod or give them a coin; a brief conversation might follow. Once we did see a group of street dwellers, all men, gathered around a subway entrance, talking and sharing food and wine; the drink seemed to catalyze the socializing. We never saw a female group. Lea, however, told us that she occasionally slept with several other women in doorways. This atypical group was formed for warmth or protection: "I sleep with the girls and we share the blanket." She does not know the names of the other "girls" who scatter hither and yon the next morning. Sometimes one will come back with a black eye.

Street dwellers did congregate at the various food programs in the area, but socializing was limited to "pass the ketchup" or conversations about the food or the service. Here we saw some hostility among street dwellers: they are uncomfortable in group situations, although they can cope when necessary.

Street dwellers are a reminder of the durability of the human species. Most of them are protected from the elements by only the most primitive insulation. They eat society's food wastes and live with little emotional support or human communality. They are urban hermits, people who have chosen or have been driven to cut themselves off from the physical comforts and human contact that most of us take for granted. Street dwellers do not pose any inordinate threat to public health, although they themselves may be more susceptible to communicable diseases such as tuberculosis.

Generalizations about street dwellers are risky: some of them will spend their whole life on the streets; others will remain on the streets only until they get a job or in some way give their life more direction. Some spend only their days out of doors. Some are more ambitious than others. After we interviewed Harry, he realized we needed him and immediately raised his price.

Some street dwellers are not very different from the average jobholder. One street woman sat and passively begged in front of the same subway entrance every day. She slept in a room farther uptown, but because that neighborhood was too dangerous to "work," she commuted daily by bus. For the present, street dwelling was her chosen profession. ☐

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1 tsp. crushed oregano, 2 cups dry bread crumbs

Cook wild rice, dissolving bouillon cubes in the water. Cut bacon slices into 1 inch pieces and fry with the butter, onions and mushrooms until bacon is crisp, onions tender and mushrooms until lightly browned. Add this mixture to cooked rice, stirring in bay leaves, oregano, celery, and bread crumbs. Salt and pepper to taste. Makes enough stuffing for a 10-14 lb. turkey.

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A Matter of Taste **by Raymond Sokolov**

The Quality of Coriander

The seeds, leaves, and oil of this parsleylike plant have been used by cooks since ancient times

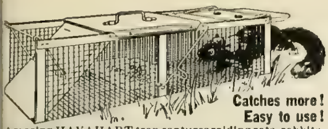
The delicate green-leaved vegetable floating in the broth looked like parsley, but its pungent aroma rose from the bowl and filled my nose. New flavors don't come along every day, so I asked the Vietnamese women who had prepared their national soup, called *pho,* for the name of the herb. "Coriander," they said. At first, I thought there must be some misunderstanding, one of those cross-cultural confusions that constantly arise when people from one place try to translate the ingredients used by cooks from somewhere else into their own culinary language. Coriander, I was sure, was a seed — a small, round brown seed that cropped up most frequently in Indian recipes.

We were both right. *Coriandrum sativum* has both seeds and leaves. Indeed, it also has little white flowers, which grow in delicate clusters that look like tiny parasols blown inside-out by the wind. So do garden variety, curly-leaved parsley (*Petroselinum crispum*) and flat-leaved Italian parsley (*P. hortense*). They are all part of a large and economically important family of plants with similar inflorescences. The Umbelliferae number more than 2,900 species, including celery, carrots, parsnips, fennel, and a large number of herbs and spices: cumin, caraway, dill, anise, chervil, angelica, lovage, and myrrh. Like coriander, they contain alkaloids, essential oils and resins used by cooks from ancient times to the present to flavor food.

The similarities between, say, carrot tops and cumin leaves or between dill and fennel seeds are so obvious that the umbellifers were the first family to be recognized by taxonomists. Actually, it was the inverted umbrella pattern of the flowers, perched atop slender stems or rays all growing from a single point, that clinched the grouping of so many plants into a single clan. In 1583, well before Linnaeus, Andrea Cesalpino, an Italian botanist, proposed the existence of a family, and Robert Morison's Umbelliferae treatise of 1672 was the first systematic study of any group of plants.

The history of this venerable family actually goes back much further. One of the first words that Michael Ventris identified, when he deciphered Linear B (the proto-Greek script that dates from 1700 – 1500 B.C.) was a form of the Greek word for coriander (which, by the way, derives from the Greek word for bedbug, *koris,* whose odor is supposed to have struck some botanical Hellene as resembling the smell of coriander). Several umbellifers are mentioned in Chinese texts of the Han dynasty. Pre-Columbian peoples also knew the umbellifers. It is no coincidence, then, that coriander in leaf form should still appear most frequently in the cuisines of the Mediterranean, Latin America, and the Far East. In this country, fresh coriander is sold almost exclusively in Chinese and Hispanic markets, and it is customary to identify it in recipes with the three names in local vernacular use: coriander; cilantro, its Spanish name; or Chinese parsley.

If you have never tasted fresh coriander leaves, it is well worth an expedition to an appropriate Latin or Chinese source. The distinct taste will surprise you. Chinese love it so much that they garnish all sorts of food with a sprig or two. Coriander's essential oil, which is extracted from the seeds of dried, fully ripe fruits by steam distillation, has a pale yellow color and has been in industrial and pharmaceutical use for centuries. Today, it is a common flavoring agent in perfumes, candy, cocoa, chocolate, tobacco, meat products, baked goods, canned soups, and alcoholic beverages, notably gin. Many



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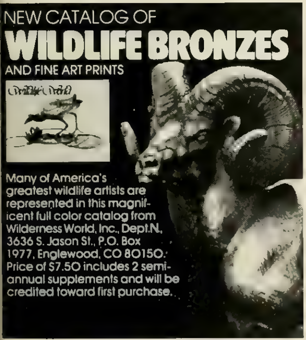

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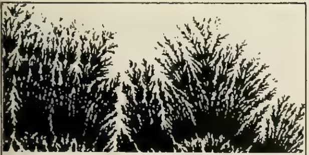

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umbellifer oils have very distinct tastes. Anise and caraway seeds may look alike, but they taste as different as Pernod and Aquavit, which they respectively flavor.

Not all umbellifers are used for their oils, seeds, and leaves. Carrots (*Daucus carota*) and parsnips (*Pastinaca sativa*) are, of course, grown for the tubers that develop below their foliage. The Florence fennel (*Foeniculum dulce*) and celery (*Apium graveolens*) are cultivated for their thickened leafstalks. Many species, however, have no economic use whatever, and a few are poisonous. The most famous toxic umbellifer is hemlock (*Conium maculatum*), the herb put in the potion that poisoned Socrates. This herb has nothing to do with that other hemlock, *Tsuga canadensis*, which is a celebrated and normally benign tree.

The toxicity of herbal hemlock is only the most extreme example of the potency of umbellifer extracts. A great many of these plants were once staple items in the premodern pharmacopeia, and it is still possible to find them quaintly described as diaphoretics, for promoting sweat, or emmenagogues, for encouraging menstrual flow.

I have no reliable information on the emmenagogic powers of oil of coriander, but I can attest to the diaphoretic role of coriander seeds ground up in Indian curries. The seeds are also used to enliven stuffings, chutneys, and pickling spice. Elizabeth David mentions the Cypriot technique of spicing crushed green olives with coriander seeds. And they are sometimes found at the center of candies, throwbacks to the old-fashioned, sugar-coated coriander-seed treats known as comfits.

Although coriander is grown quite easily in this country, it is still perceived as an exotic ingredient, especially when used for its leaves. But they can be chopped as easily as ordinary parsley and mixed into all sorts of dishes, usually in small quantities, with remarkable and dramatic results. Chopped coriander leaves, says Paula Wolfert in *Mediterranean Cooking* are "one of the most important ingredients in Moroccan food, and, to a lesser degree, the food of Algeria, Tunisia, and the Middle East." She goes on to describe Palestinian fava beans dusted with chopped coriander and garlic, as well as squab braised with saffron, aniseed, scallions, and chopped coriander in the braising water, then sprinkled with more coriander and scallions mixed with lemon juice.

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Moroccan meatballs or one of those delicious Moroccan casseroles called *tagines* will need coriander leaves to produce the authentic flavor (see recipe). Seeds are, incidentally, not a possible substitute, since their flavor is completely different from that of the leaves. For those who live far from a fresh source of leaves and are unlikely to trek out very often for a supply, the answer is coriander water. Purée three cups of tightly packed leaves in a blender with two cups of cold water. Place the purée in an ice tray and freeze into cubes. The cubes can be popped out and stored in a plastic bag. Each cube is equivalent to two tablespoons of chopped greens and can be used for any recipe except a salad, where fresh leaves are essential.

Thus supplied, you are in a position to try a very cosmopolitan repertory. For instance, you might prepare fresh-killed carp, steamed in the Soochow manner, with a sauce composed of small amounts of oil, soy sauce, sugar, salt, cooking wine, cayenne, and chopped coriander. Mexicans marinate snapper in lime juice, then bake it in a cup of oil with onion slices, chilies, and two cups of chopped coriander.

Perhaps coriander leaves come into their own most completely in Indian cookery. Indians call them *dhania* and use them with everything from carrots and peas to sweetbreads. There is even a very rich lamb stew flavored with almonds and sauced at the last minute with cream and coriander leaves.

Finally, there is no need to stick with established recipes for an herb as versatile as coriander. Once you have some, you can follow your own taste and substitute it for parsley as a garnish on almost any main dish. It will make an unusual addition to tabbouleh, the Middle Eastern bulgur (wheat) salad usually flavored with mint. And you can mix chopped leaves with hamburger meat or yogurt or chicken soup. Just go slowly, adding a little at a time, because fresh coriander is like superparsley and can overpower other flavors if you don't watch out.

Stuffed Vegetable Tagine

(Adapted from Paula Wolfert's recipe.)

5–6 medium zucchini (about 2 pounds)
5 large ripe tomatoes, plunged in boiling water and then peeled
Salt
¾ lb. ground beef or lamb
Black pepper
½ teaspoon ground ginger

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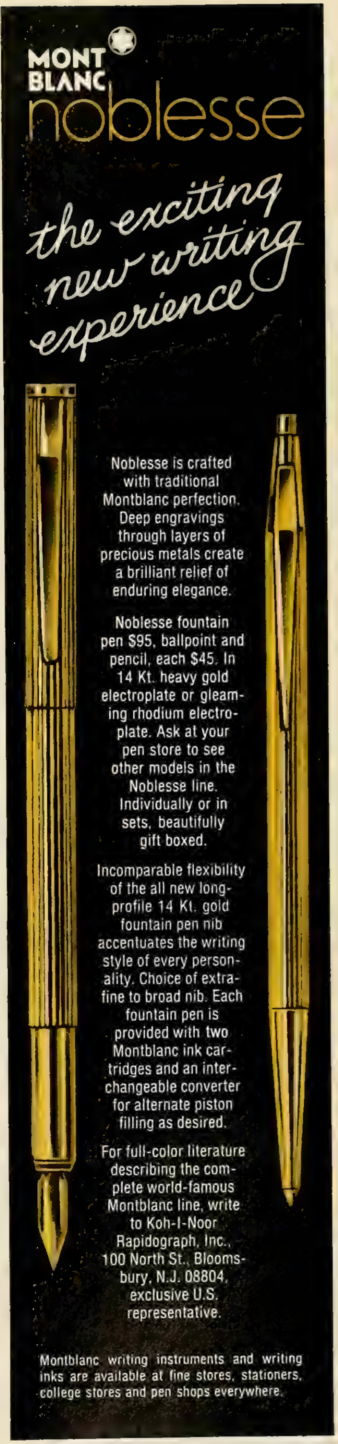
1 two-inch cinnamon stick
3 cloves garlic, peeled and crushed
¼ cup chopped fresh coriander leaves
½ teaspoon dried mint
¼ cup raw rice
1 cup grated onion
¼ cup unsalted butter
2–3 tablespoons lemon juice
2 tablespoons oil
3 eggs, well beaten

1. Wash and trim zucchini and slice into 2-inch rounds. Cut a thin slice from the top of 4 of the tomatoes and reserve. Scoop out the cores of the zucchini rounds and the tomatoes. The pulp can be reserved for soups. You should leave only about ¼ inch of the zucchini. Sprinkle the hollowed zucchini and tomatoes with salt and let stand for 30 minutes.
2. Meanwhile, prepare the stuffing. Place the meat, ½ teaspoon black pepper, ginger, cinnamon stick, garlic, ¾ of the coriander, mint, rice, onion, butter, and 1½ cups water in a saucepan. Bring to a boil, reduce heat, and simmer, uncovered, 25 minutes, or until the rice is fully cooked and the mixture is thick but still juicy. Stir in the lemon juice and correct the seasoning with salt and pepper.
3. Remove the cinnamon stick and let cool. Up to this point the dish can be prepared in advance.
4. Preheat oven to 350 degrees.
5. Rerinse, drain, and stuff the tomatoes and zucchini loosely with the meat mixture. Oil a baking dish and arrange the stuffed vegetables in it. Pile the remaining stuffing over the tomatoes. Then cover the tomatoes and the stuffing with the tomato tops and slices of the remaining tomato. Sprinkle with salt and pepper. Cover with aluminum foil. Pierce the foil in two places and bake 30 minutes.
6. Remove the foil and transfer the dish to the upper level of the oven. Raise heat to 400 degrees and continue baking for 20 minutes.
7. Meanwhile, beat the eggs with remaining coriander plus salt and pepper to taste. Pour the mixture over the stuffed vegetables and return to the upper shelf of the oven to bake for 10 minutes or until the egg solidifies. Serve hot.

Yield: 4 to 6 servings

Raymond Sokolov is a free-lance writer whose special field of interest is the history and preparation of food.



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A Naturalist at Large

Walking the Railroads

Left to nature's ways, abandoned rail lines produce a rich assortment of flora and fauna

Whatever its economic significance, the decrease of American train traffic has left us with hundreds of uncrowded trails throughout the nation. Government-subsidized trains still link large population centers, but miles of tributary tracks now lie abandoned, the passengers and freight they once carried long since shifted to highways.

Some environmental and recreational groups propose purchase and conversion of these lines to formal hiking or biking trails, but other than a few showpiece efforts, little decisive action has resulted. The idea is good, but maybe we should also allow some old spurs to rust away in the second growth. For by the time a railroad track has been converted to a formal trail—with ready access, civic pride, and signs of civil admonition decorating its length—it is back to being not much different than a busy railroad: one technological switch exchanged for another. Completely abandoned track, however, takes on a look of wilderness, sprouting the always incipient possibility of spontaneity.

I like to walk any rusty spur of warped rails and crazily tilted ties, one whose heaviest freight has long since whistled past some boarded-up country station. Such tracks — going nowhere that folks and their luggage still want to go—now head into the woods like old corduroy trails. With their frost-heaved crossties split and sunken and their vine-snared rails agape, these remnants of noisy commerce demonstrate how steel loosens its grip.

I also hike still shiny lines whose freights are just frequent enough to stunt the weeds between rails. Whether corroded or polished, the tracks form a kind of inverted rut, a trail in bas-relief As human roads go, it seems less imposed, less permanent than most. I does not cap earth so finally; it buries no ground.

Dedicated track walkers know tha railroads have always carried traffic other than trains. Fifty years ago botanist B. Shimek identified railroa rights of way in the Midwest as important remnants of original prairie. Railroads have also channeled numerou weeds across the country. On still functioning lines, a track walker comes to realize how conducive the roadbeds are to the spread of floral associations ove continental distances. Mostly alien species, the plants survive constan trimming, flowering early and late i the grease of axle sweepings. Midwestern rails frame alfalfa, chicory, bouncing Bet, green amaranth, white and yellow sweet clovers, peppergrass, mustard, lady's thumb, cinquefoil, an common ragweed. Locomotive bellie scrape the bristles and beards of downy brome, foxtail, and *Panicum* grasse clumped between the ties, their uppe stems stiff as caked brushes. Late in th season the only green lies low in th biennial rosettes of spotted knapweed and common mullein.

My favorite railroad hike spans several kinds of environment. Across swampy lowland stretch, the track be is a dike, sloping down on both sides t

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by John Eastman

ctail openings and gray dogwood —
n in shrub of the wet margins. Late in
t year, the once firm and glossy cattail
hds have become frayed lint wads
fing apart. Now, in the windy, rain-
gy weeks, the white-footed mouse
(*romyscus leucopus*) plunders them.
er colored, with white underside and
red tail, the species is nocturnal,
lg whiskered, and big eyed. On a
dgwood branch, a mouse heaps an old
cbird nest high with the downy stuff,
tn tunnels a residence into its midst.
breathing flanks mold the clinging
ier walls of its nest, and I imagine
tt hardly a surface separates felt from
pt therein. That merger of plant and
amal, I have also imagined, extends
itime and space to incubating cat-
bds, fat pollen-smoking cattails, blos-
sning dogwood, and leaking land.

Along the drier margins of the track,
omyscus's work can be seen in wads
ohay, matted just above arm's reach in
t densest grapevine snarls. The
muse also wedges its dwellings inside
cavities, logs, and crevices beneath
road trestles. There is simply no
ong side of the tracks for this animal.

For the wildlife biologist, railroads
en provide convenient strip-census
ites. Last spring, my focus was on
ds, and I ran a nesting survey along
tracks. Now, half a year later in the
fless brush, my bits of red tape still
rk the stations. Eyesores now, those
s were beacons in the jungle of June.
ost of the nests remain too, even a
g-lost cardinal nest I had given up.

But it's another season, virtually
other country altogether, and these
idual muds and sticks hold no re-
ual warmth. Hot hormones did not

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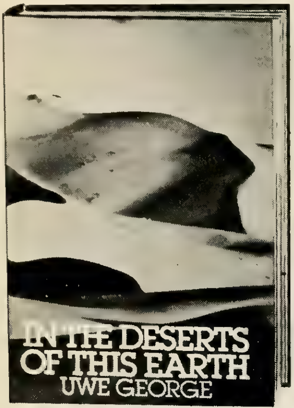

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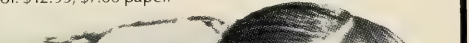

WELCOME OF TEARS

THE TAPIRAPÉ INDIANS
OF CENTRAL BRAZIL

CHARLES WAGLEY

author of *Amazon Town*

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build them for cold exposure; hence they look jelled in the brush, seemingly materialized from the leaf-ripping wind. Yet these monuments of a different season mark the birth sites of goldfinch, catbird, cardinal, robin, flycatcher, and rose-breasted grosbeak. The tags mark where I witnessed one, two, four eggs appear: where the young birds jostled, feathered, fledged. Now, in the autumnal chill, I am suddenly nostalgic for sweat.

Black-capped chickadees, white-breasted nuthatches, downy woodpeckers, and dark-eyed juncos are the common residents now. Cardinals, the males red as bittersweet berries, flit in the thickets and utter sharp, quick notes. Goldfinches still bounce in flight, but yellow feathers are few—the birds' dullness, however, is only of color, not pattern. Tufted titmice rasp and buzz beside the roadbed. Blue jays bicker.

Few birds sound melodious now. November's style is staccato—the notes exclamatory, mostly monosyllabic. One bird with something resembling a song is the tree sparrow, down from tundra for the winter. Since the bird spends most of its time on the ground or in shrubs, its common name reflects little more than the grand old ornithological tradition of dogmatic misnomer.

Among the mammals here, muskrats and fox squirrels often walk on a rail for considerable distances; muddy pawprints of raccoons, opossums, and feral cats also attest to the rails as a path. Something about the smooth straightness evidently satisfies some motive impulse. I don't know why, but I, too, like to walk the rails, and I've become very good at it.

Red foxes deposit signal feces on this as on other roads. Last summer, dew glistened on steel at five o'clock in the morning, and robins, perched on the polished bar, excreted globs of mulberry. Then the rails began to clank as the morning sun warmed them. The summer railroad is a fast heating unit for the coldblooded and morning sluggish; hognose snakes and blue racers unwind and lie along the ties. For all these walkers, perchers, baskers, the inverted rut — linear in the nonlinear webs of wilderness — is a biotic ingredient, adapted by wildlife in ways analogous to plank bridges, stone fences, and telephone wires, and it is traveled without much surprise.

Best proof of this integration is the number of creatures killed by the infrequent trains. Only a year's listing of that crushed and mangled can provide a fairly complete sample of marginal wildlife. Most of the snakes and turtles are just smashed in place. Mammals are most often killed running away from an oncoming train. In 1970, eight hundred moose in Alaska were killed by trains because they could not escape the actual channel cut through the deep snow. But here, a simple flanking move could save the fleeing animals—and probably often does. However, when the train's headlight-beam — a long shaft of light hemmed by darkness — imposes the behavioral conditions of escape, the victim's outrunning pattern is hopeless and bloody.

In the daytime, birds — perhaps disoriented by the movement in another way — sometimes fly directly into the train. So one of a train's unintended effects is that of behavioral trap, and the aspect of linearity is lethal.

Railroads also exert their own adaptive pressures by influencing animal mortality and creating human dilemmas. In September, I watched a grasshopper thrust its ovipositor into the wide seam of a crosstie. Egg laying was imminent. The abdominal tip, questing for the resistance of soil, met only the gap between timber slivers. I could have placed the insect three feet away on decent ground, thereby casting my ballot for one more spring. And I could have done it easily, for the female grasshopper at egg time has lost her behavioral flight releasers. I saw the grasshopper as an inch-long existential dilemma confronting me. By exercising a more vital business on this railroad than dodging me, it suddenly paused, as if it had asked, a question: Would I, from the heights of my high brain, help it, help another spring come, implicitly help the limping wildness of the world?

After watching a few moments longer, I made my decision. I walked away and left the grasshopper struggling to find a place for its next generation. It would meet the selective demands of its chosen site or not. Spring will come or not. It can't be helped, and *that's* the not-so-limping wildness of the world. Perhaps the insect had no business trying to adapt to a railroad. Maybe none of us do, but I can't know that. I can only walk the line to see where it goes. And vote for frankly abandoned ruts.

A free-lance writer and editor, John E tman has written several articles for Natural History. *He lives in Kalamazoo, Michigan.*

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Guayule Bounces Back

A desert shrub that supplied the Aztecs with rubber could change our dependence on petroleum-based synthetic rubber.

In 1910, about 10 percent of the world's rubber and half the rubber used in the United States were supplied by guayule, a small shrub native to the Sonoran and Chihuahuan deserts of Mexico and the southwestern United States. A member of the daisy family, guayule was familiar to the Aztecs. They made rubber balls for a basketball-like game by chewing guayule twigs, spitting out the pulp, and saving the remaining elastic mass of rubber. Early commercial rubber production was simply factory adaptation of this Aztec technique. The harvested wild plants, containing rubber in individual stem and root cells, rather than in tappable latex ducts, were first dumped into boiling water to remove the leaves (which contain no rubber), to wash the plant, and to coagulate the rubber. The washed and defoliated plant was then ground and the slurry deposited in a flotation vat of hot water containing alkali, which facilitates rubber extraction. The rubber floats to the surface in wormlike strands that can be skimmed, while the rest of the plant, the bagasse, becomes waterlogged and sinks. After this process is repeated several times, the rubber produced is reasonably free of gross impurities such as soil, leaves, and wood. About 20 percent of the rubber's weight will be resins, which make the rubber tacky and cause it to age and crack more rapidly. Soluble in warm acetone, these resins are easily extracted from the rubber, which then is indistinguishable from the product of the rubber tree, *Hevea brasiliensis*.

By about 1980, *Hevea* rubber production will probably rise to about five million tons per year, constituting about one-third of the world's current rubber needs. The remaining two-thirds will come largely from the petroleum-based synthetic rubber industry. The Soviets still produce some rubber from the Russian dandelion, but the other 2,000 or so species known to contain rubber are not now exploited commercially. But the rise in rubber use, a projected shortage, and the cost or scarcity of petroleum have meant that guayule and other rubber-bearing plants might be pressed back into economic service. This possibility would be especially useful to the United States, which currently uses one-fifth of the world's rubber supply. In 1974, we imported more than 700,000 tons of natural rubber at a cost of half a billion dollars, making rubber our third largest import of inedible crude material.

I first encountered guayule in 1943 when, as a new Ph.D., I went to work on the wartime Emergency Rubber Project at the California Institute of Technology. As a country at war, the United States needed rubber tires for airplanes, trucks, Jeeps, and cars. But because the Japanese had overrun the Malay Peninsula, 90 percent of the world's rubber was out of our reach. To solve this problem, two projects were quickly organized: one was to produce natural rubber from guayule; the second, synthetic rubber from petroleum. Between 1942 and 1946, during the guayule project, about 1,000 researchers planted more than a billion seedlings over 30,000 acres, producing about three millon pounds of rubber. Late in 1945 production from two California factories approximated fifteen tons of rubber per day, while in Mexico roughly four factories turned out twice as much. After only three and a half years, the project scientists knew more about guayule than almost any other plant; had the program continued, improvements in guayule genetics, agronomy, pest control, milling, and purification would have increased production much more. But outpaced by the production of synthetic rubber, the guayule project was abandoned in 1946 and its fields plowed under or burned. Recently, after taking a long look at America's needs for the future, a National Academy of Sciences panel ha recommended that the production o guayule rubber be resumed.

Guayule's great virtue is that it is completely renewable resource, whos use would free for other purposes petroleum now used to produce syntheti rubber. Guayule can be grown in th United States and Mexico, eliminatin our dependence on most foreig sources.

Unlike production of synthetic rubber, producing guayule rubber does no cause pollution. Guayule grows well i semiarid regions and needs only abou sixteen inches of rain a year, althoug optimal rubber production does requir some irrigation water. And since muc of the land on which it could be grow lies on Indian reservations, it coul possibly become an economic boon to generally impoverished segment of th American population.

Early in the twentieth century, group of financiers, including Rockefeller, Guggenheim, Aldrich, and Baruch, invested $30 million in the Continental-Mexican Rubber Company This American-financed venture produced much revenue for Mexico, an desert land prices in both the Unite States and Mexico boomed in anticipation of a continued bonanza. But overuse of wild plants and failure to replan (sixteen million pounds of rubber wer imported into the United States in 1912 alone) led to a virtual disappearance o the new industry's basis, and mills were forced to close. In Mexico, the revolution gave the industry its *coup de grâce* as a large operation. Minor operations continued in California. In the late 1920s, Britain's control of Malaya and its resultant rubber monoply suddenly increased rubber prices threefold (much as the OPEC nations have recently done with petroleum, and Brazil with coffee). In Mexico and California, guayule rubber was profitable again and production resumed. A then Maj. Dwight D. Eisenhower, assigned to study guayule in connection with national security, recommended further development of the industry, but the by Arthur W. Galston

vorld depression of the 1930s ostponed the project until its shortved resurrection in 1942.

Mexico, however, has never stopped roducing guayule, and at present a ilot plant in Saltillo, in northeast Aexico's Sonoran desert, can process ne ton of shrubs daily. About 2.6 milon tons of wild guayule grow in an rea of approximately 10 million acres the states of Durango, Coahuila, acatecas, Chihuahua, Nuevo León, nd San Luis Potosí, just south of the ig Bend area of Texas. The project's oal is 30,000 tons of rubber per year, om a harvest of about a third of a iillion tons of plant. Hence, the Mexians have a nine-year supply of guaule: the harvest of about one-ninth of e total number of plants per year ould allow adequate regrowth of edlings. A harvest of wild shrubs obously depends on a large supply of expensive hand labor, available in Iexico, but not in the United States.

If guayule growing were revived in e United States, the main location ould probably be about five million res of the arid zones of Texas and alifornia, connected by a narrow band mposed of part of southern Arizona d a small portion of southwestern ew Mexico. But as the National cademy of Sciences panel points out, e industry would be economically viole only if it were to benefit from the me kind of research that has led to a nfold increase in *Hevea* production ver the last thirty years. The mergency Rubber Project showed at guayule can be genetically imoved through conventional selection d breeding techniques. Innovations chemical weed control, insect conol, and rubber technology, as well as w insights into the biochemistry of bber formation in plants, can be excted to increase yields. Agronomic cks, such as harvesting only the tops d leaving the roots to resprout, might orten the current three- to four-year cle before rubber harvest is optimal.

Along with each ton of purified rubr, the guayule plant produces about

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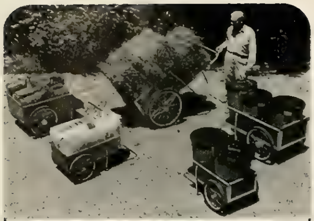

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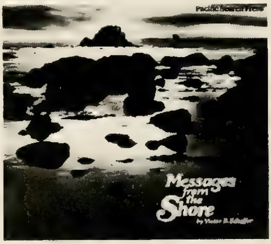

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Even if petroleum were indefinitely and cheaply available, demand for natural rubber would grow. Rubber is a polymer, a very large molecule made up of repeating units of isoprene—a small molecule made up of four carbon atoms in a row and one branching off the chain and eight hydrogens. When isoprene is polymerized, or linked in a specific way to make rubber, the units join end to end along the unbranched four-carbon chain. The isoprene unit has two double bonds involving four of the five carbon atoms; each of these two double bonds is rigid, whereas the carbons are able to rotate freely around the single bond. This means that there are two possible ways, known to the organic chemist as *cis-* and *trans-* configurations, for the carbon atoms to be grouped around the double bond. In natural rubber from *Hevea* and guayule, the bonds are all *cis,* that is, the branched carbon atoms all protrude from the same side of the backbone of the polymer. This configuration gives maximum elasticity and bounce to the molecule. Even a small percentage of *trans*-links can markedly reduce the desirable qualities of the molecule. In synthetic rubber manufacture, both *cis-* and *trans*-linkages are produced, so that the resultant molecule is weaker than natural rubber. While perfectly acceptable for many commercial uses, the synthetic product does not stand up well in tire sidewalls; accordingly, all tires must have at least some of the natural polymer, both to give basic strength and durability and to serve as a kind of template around which the synthetic units are deposited in a regular way. Since tires account for about 75 percent of all rubber used in the United States, the reason for continued re-

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To the plant physiologist, guayule nd other rubber-producing species ose the additional lure of research. Why does the plant make rubber, since ubber is inert metabolically and cannot e used as a food source? How does the lant manage to achieve 100 percent *s*-bonding as it fabricates the longhain isoprene polymer? Why is rubber ade only in stems and roots, not in aves? How can guayule compete so ffectively with other plants in the arid esert environment? Part of the answer o the last question involves the secreon from guayule roots of a substance at retards the growth of nearby seedngs. This kind of "chemical warfare" common in desert plants, and in 44, working with James Bonner at alTech, I was able to identify *trans*nnamic acid as the main effective ompound. Oddly enough, this same olecule later found use as an antagost of auxin, one of the major plant owth hormones. As far as I know, ayule is the only plant known to use a tural hormone antagonist in this way. o doubt this is not the last surprise we n expect from guayule.

thur W. Galston teaches biology at le University.

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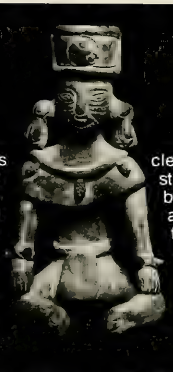

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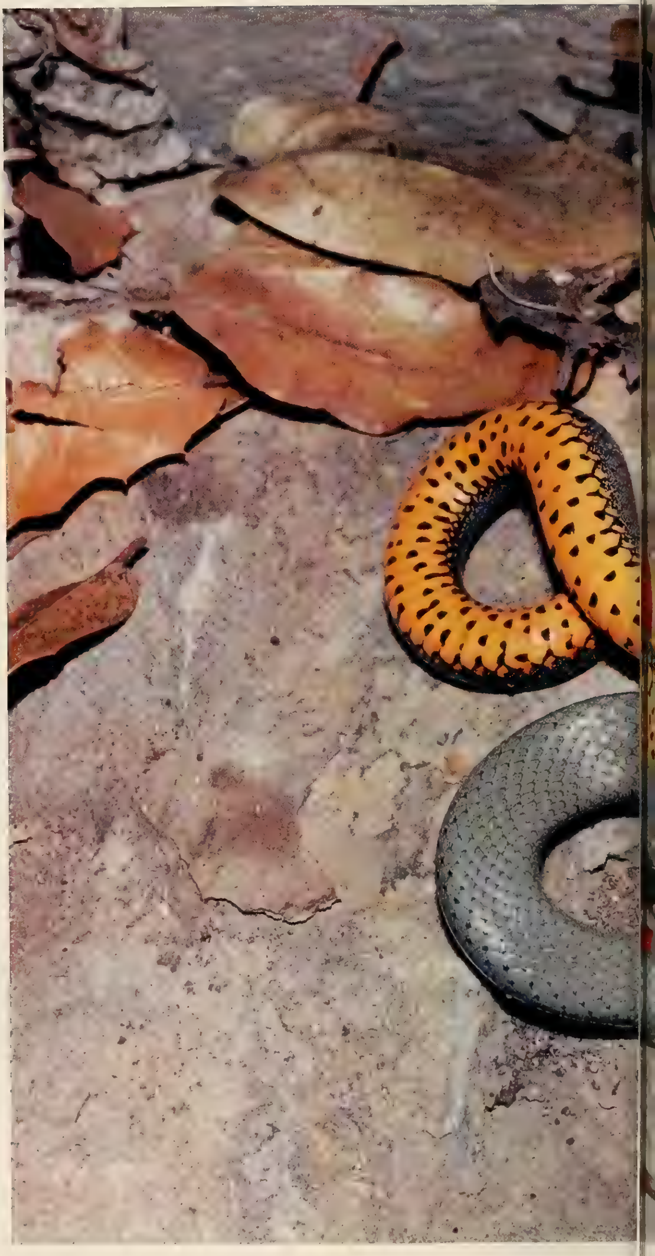
A SPECIAL ANNOUNCEMENT

Hall of Reptiles and Amphibians

On November 18 in the Chinese Year of the Snake, 4675, roughly 350 million years after amphibians made their first appearance on earth, the Museum's new Hall of Reptiles and Amphibians will debut. Reptiles, which came on the scene about 50 million years later, share the billing with their amphibian progenitors.

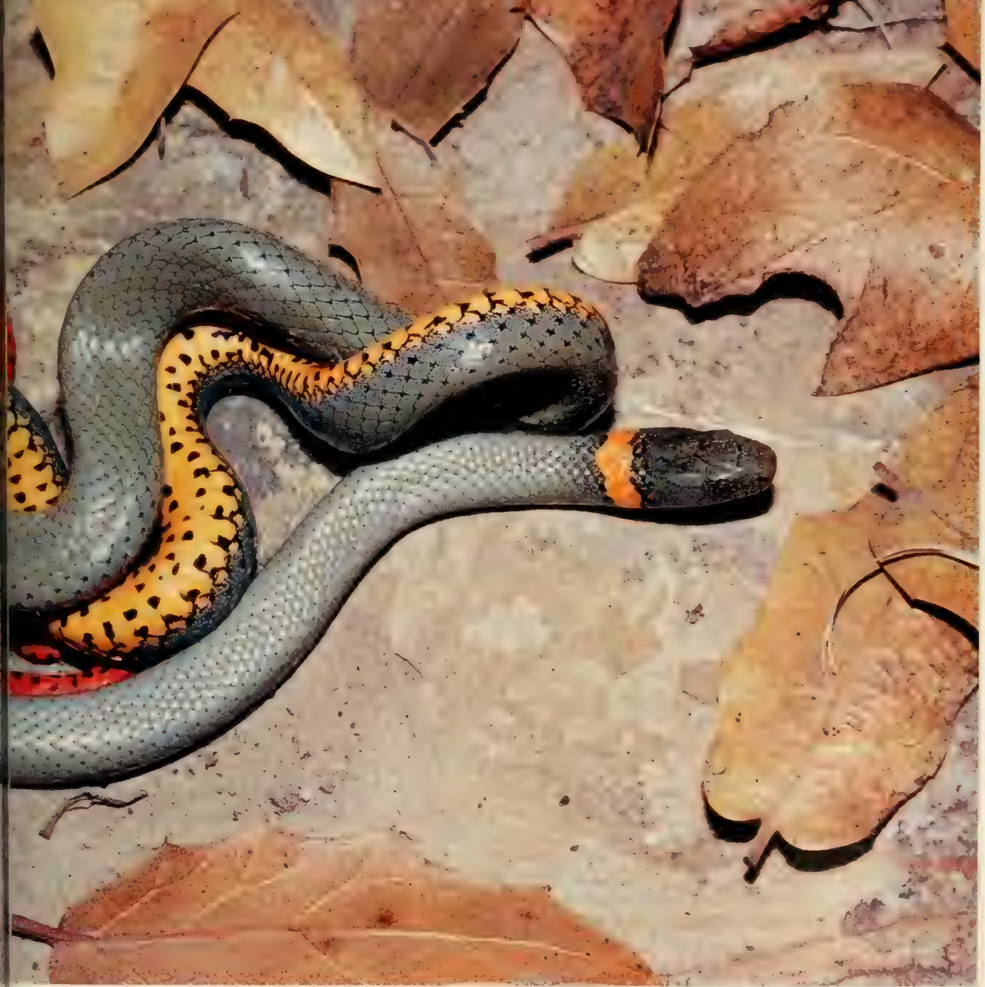
The evolutionary paths taken by the amphibians and reptiles are remarkable for their breadth and variety. When the first amphibianlike creatures found a suitable niche along some ancient shoreline, new possibilities for life on earth took form. During the Permian period, some 30 million years later, reptiles were the dominant land animals. Dinosaurs came and went, but other reptilian experiments were to be of greater duration: the first shelled eggs were produced by reptiles, and one of their myriad evolutionary lines gave rise to the birds. Another group, the therapsids, produced the precursors of today's mammals.

Museum halls have also undergone a remarkable evolution. Beginning as curio cabinets housing the odd and exotic leavings of nature, the new generation of exhibition areas pulsates with holistic renderings of ecological systems. Gone are the dusty cases and rows of entombed carcasses. Today, a museum of natural history is a vital



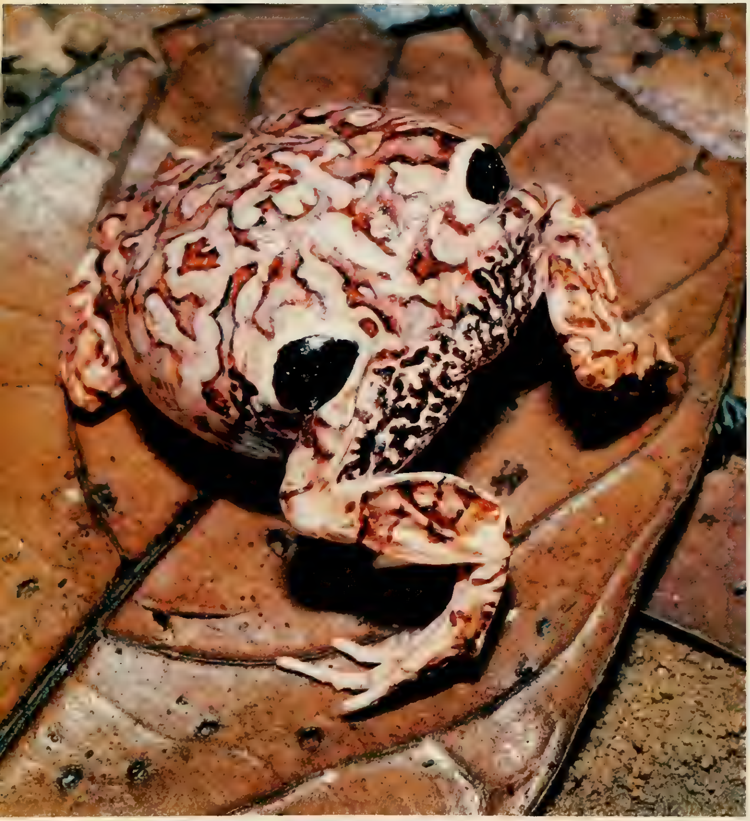
By exposing the vivid, contrasting color of its underside, a ring-necked snake can startle predators. A model depicting this defensive posture is on display in the new hall.

Photographs by Richard G. Zweifel



Richard G. Zweifel

A featured player in the hall is this South American frog, Physalaemus natteri, *below. When disturbed, it presents its hind end on which are two "eye spots." A predator would presumably take one look at this creature and search elsewhere for a meal. The banded gecko, right, an inhabitant of desert areas in the southwestern United States and Mexico, stores food reserves – in the form of fat – in its tail. This adaptation enables the gecko to survive lean periods.*



place: its halls are interlocking stages on which thematic dioramas arrest the eye and inform the beholder.

"Three-dimensional textbook" would be an apt phrase for the new hall, located on the third floor of the Theodore Roosevelt Memorial Building. The Komodo dragons on display are impressive enough to look at. These giant lizards command attention. But there is more to being a huge lizard than weighing two hundred pounds. What adaptations to their environment have the world's biggest lizards made? What do they eat and how do they reproduce? In their habitat exhibit, a group of "dragons" is scavenging a wild boar. Careful study of the tableau reveals a series of clues to this lizard life style, and a vivid picture emerges.

The new hall is primarily a teaching hall. The specimens are not a taxonomic roll call; they are chapters in the history of evolutionary biology. Amphibian and reptilian feeding and reproductive strategies have their parallels in other orders of animals. Life flows and adapts, and the survivors must meet the challenges of newer worlds. In this age so conspicuously dominated by mammals (*Homo sapiens* in particular), amphibians and reptiles continue to play an important role in a wide variety of ecosystems. Their interactions with their environments have lessons for man.

Featured players in the hall are poison-dart frogs with brilliant color so variable that two nearby populations look like completely different species; a twenty-five-foot python coiled around a tree and ready to strike a preening cock jungle fowl; an all-female species o lizard that has eliminated the need fo males; a fourteen-foot crocodile and a twelve-foot alligator, both obtained by the Museum many years ago. They would have a slim chance of reaching such lengths today; they would probably be shot by man much earlier in life. Snakes that look like worms and lizards that look like snakes share space with the box, spotted, and painted turtles o the northeastern United States. Thei

havioral and physiological adapta-ns are shown *in situ*.

The old hall of amphibians and rep- s opened to a wondering public in 1920s. By 1969, out of date and finitely the worse for wear, it had ched the end of its line. Planning for uccessor had gone on for some time. years, more than a million dollars, l the newest techniques for bringing drama of nature to life went into the ation of the new hall.

"In the interests of conservation, we d as many specimens from the old l as possible," reports Richard eifel, chairman and curator of the partment of Herpetology. Using in- uious methods of molding and casting plastics and fiberglass, new specimens were created and old ones were given a new lease on life. In some instances, the new lease meant some startling transformations. A leatherback turtle, one of the veterans from the old hall, began life as a male. No longer satisfied to simply show a leatherback as one of the world's largest reptiles, the exhibit on these sea turtles was planned to depict egg laying on a beach. But no female was available and the species is too threatened to allow the collection of one. So, through the magic of plastic surgery, the old male underwent a sex-change operation that was a complete success.

From myths that tell of the snake as earth mother and of turtles as supporters of the universe, we learn of the symbolic importance of these reptiles. From the blowguns of the Choco Indians of Colombia and the role of the green sea turtle in the colonization of the New World, we learn of the pragmatic uses to which man has put amphibians and reptiles.

A bottle of liquor (a Japanese concoction with the look of bourbon) in the new hall also tells us a bit about ourselves. In making the drink, the distillers toss live venomous snakes into the fermenting liquid; the unfortunate snakes become part of the spirits. The label reads: "Old Mam."

Frederick Hartmann

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Celestial Events

by Thomas D. Nicholson

Sun and Moon In November, the sun moves to nearly 22° south of the equatorial plane while traveling eastward through the constellation Libra. It enters Ophiuchus about November 23 and Sagittarius after mid-December. Although winter is still three weeks off at the end of November, daylight by then is within sixteen minutes of its shortest duration for the year, and sunset comes only one minute later than on December 7, the date of the earliest sunset.

The moon is in the morning sky in November (and early December). It becomes visible in the evening as a slim waxing crescent on November 13 and remains prominent in the evening till late in the month. Last-quarter is on November 3, new moon on the 11th, first-quarter on the 17th, and full moon on the 25th. In December, the last-quarter moon is on the 3rd and new moon on the 10th.

Stars and Planets Although none of the bright planets (except Mercury, which is poorly placed) is an evening star, Jupiter appears on the Star Map because it rises shortly after sunset and will be above the eastern horizon in the early evening. Above and to the right of the twin stars Pollux and Castor in Gemini, Jupiter will be the brightest starlike object in the sky until Sirius rises later. By midnight, Mars will be visible in the east just below the twins. And Saturn will then be rising to the right and below Mars.

The planets will be best in the morning. Just about dawn, Venus will be low in the east; Saturn will be halfway up the sky in the south, quite close to Regulus in Leo (Saturn is the brighter of the two); Mars will be to Saturn's right; and Jupiter, farther to the right, will be high above the southwestern horizon and above Orion.

November 1–3: The waning gibbous moon moves past Jupiter and Mars, while the other morning planets are in conjunction with nearby stars: Saturn with Regulus and Venus with Spica.

November 4: The Taurid meteors (15 per hour) reach maximum.

November 5: Saturn is near the crescent moon this morning.

November 9: The moon passes very close to Venus, covering it (an occultation) over southern skies.

November 12: The moon is at perigee (nearest earth).

November 16: The Leonid meteor shower reaches maximum. Although sparse (up to 15 per hour), the meteors are swift and often bright.

November 20: Venus is in conjunction with Uranus.

November 27: The moon is at apogee (farthest from earth).

November 27 – 28: Look for Jupiter near the moon from early evening until dawn.

November 30 – December 1: Mars rises near the moon late at night.

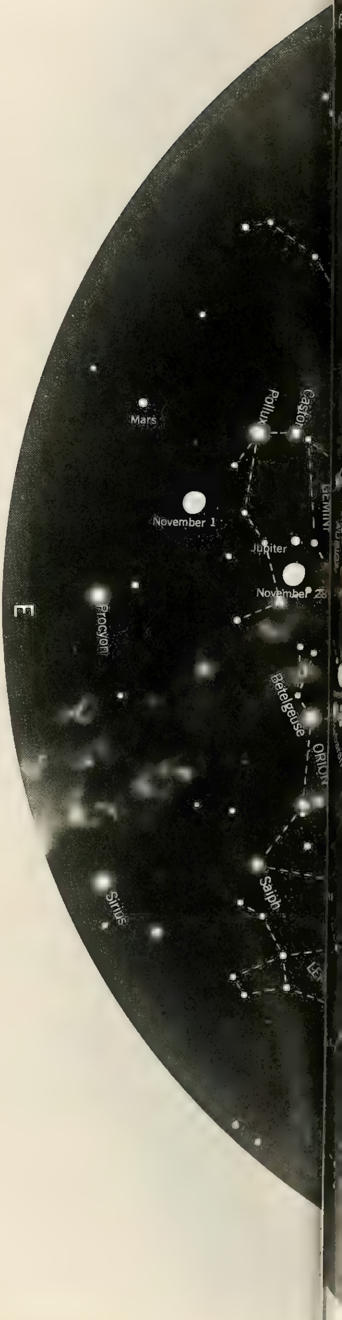
December 2–3: The moon is near Saturn from late evening until morning.

December 3: Although Mercury is at its greatest distance to the sun's left (east), it is poorly placed as an evening star.

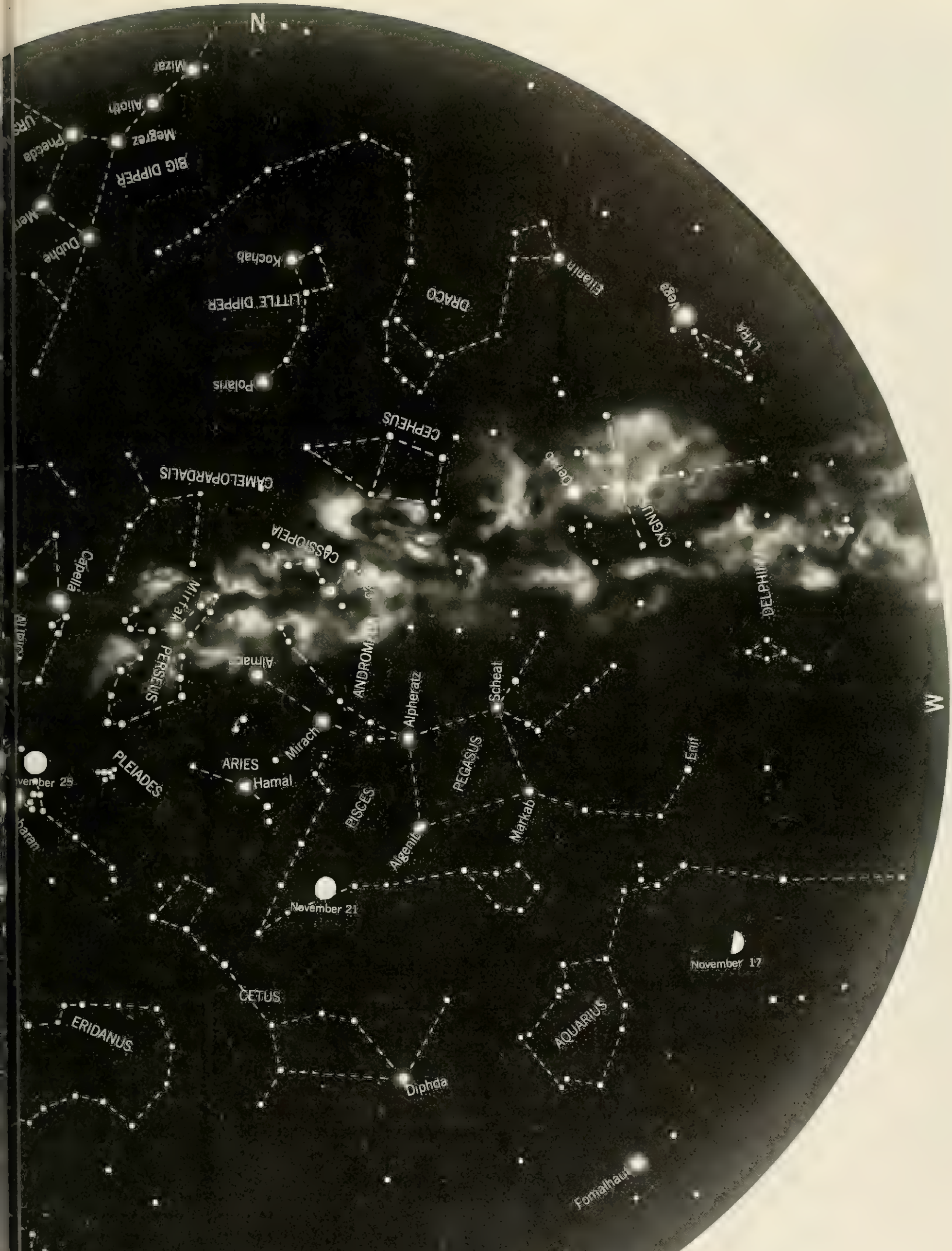
December 7: The earliest sunset of the year occurs.

December 10: Perigee occurs six hours after the new moon, enhancing the effects of spring tides. Look for exceptionally high tidal levels tonight and tomorrow.

December 11 – 13: Mercury, Saturn, and Mars become stationary among the stars, and all three begin to move westward (retrograde): Mercury on the way to conjunction with the sun; Saturn and Mars as they approach opposition from the sun.



★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on November 1; 10:20 P.M. on November 15; 9:20 P.M. on November 30; and 8:20 P.M. on December 15; but it can also be used for an hour before and after those times.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Helmut Wimmer

by Stephen P. Maran

Ring Galaxies

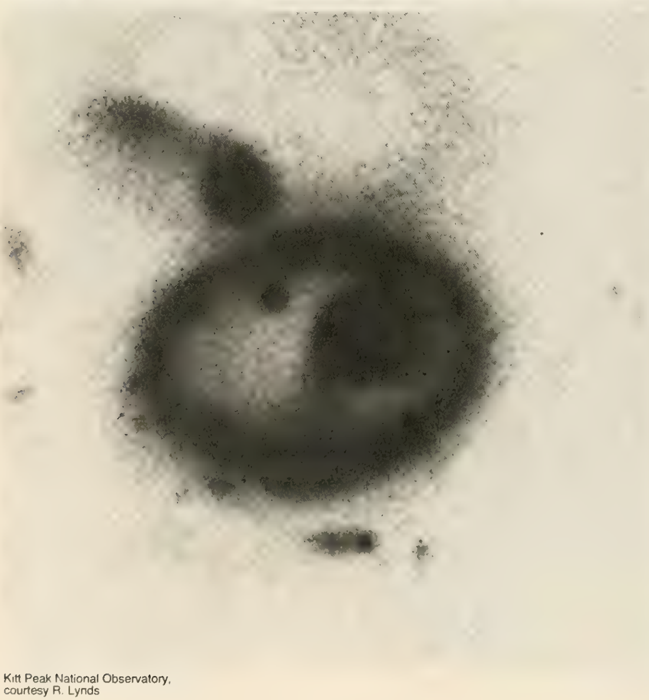
A recent finding leads to a new explanation of the formation of these peculiar objects

In the past few years, astronomers have recognized a class of rare galaxies that are shaped like giant smoke rings. It appears that these "ring galaxies" may be the short-lived remnants of cosmic collisions in which one galaxy has struck through the heart of another and then passed on into space.

A galaxy is a vast collection of stars, gas, and dust, all held together by mutual gravitational attraction. These assemblages are occasionally referred to as "island universes" in the even vaster expanse of the cosmos. A familiar example is the famous Andromeda Galaxy, pictured in nearly every text on astronomy. The Andromeda object is a fine specimen of a spiral galaxy, resembling a huge, flat pinwheel with a central spheroidal bulge at the galactic nucleus. Spiral galaxies come in a wide range of sizes and shapes, but in each case the arms of the pinwheel are confined to a thin, flat zone known as the "galactic disk."

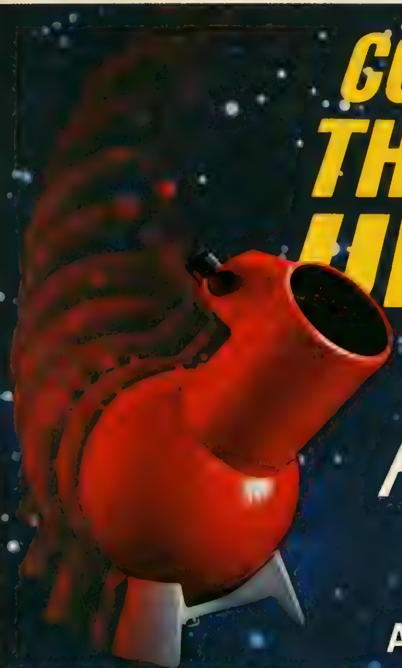
Other common types of galaxies, some of which also have disk structures, are ellipsoidal or spheroidal in shape or are so-called irregulars o formless or chaotic appearance. The very small minority of galaxies that d not fit into this classification scheme (spiral, ellipsoid, spheroid, irregular) are known collectively as "peculia galaxies." Even among this relatively rare class, it appears that only about one peculiar galaxy in a thousand is a ring In almost every case, a ring seems t have an adjacent companion galaxy.

The earth has no nearby ring galaxies, hence they are small, faint objects as we observe them. Telescopi observations revealed the first of thes objects as long ago as the early 1940s and a few brief papers discussing individual rings appeared in the 1960s. I was not until the present decade, however, that they became recognized as distinct class of object, one that shoul be subjected to systematic investigations and comparative studies. B 1973, when the first extensive study o this type was made by John C. Theys a a Ph.D. thesis in physics at Columbi University, only about a dozen ring had been found. Since then, they hav attracted much greater attention amon astronomers, and many regions of th sky have been carefully searched, s that by now at least six dozen rings hav been found.



Kitt Peak National Observatory, courtesy R. Lynds

A negative print made by superimposing three four-meter telescope photographs shows the large off-center nucleus in the ring galaxy II Hz 4. A faint secondary ring can be seen immediately above the main ring. This double-ring galaxy is the first known instance of such an object.



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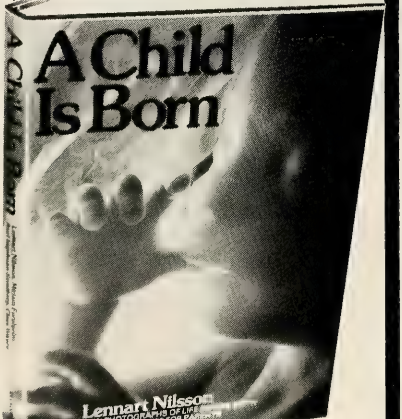

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A typical ring galaxy is perhaps 60,000 light-years in diameter and 100 billion times more massive than ou sun, according to rather uncertain estimates. These quantities are somewhat smaller than those characteristic of a typical large spiral galaxy such as that in Andromeda. John Theys (now an astronomy professor at the State University of New York at Stony Brook) noted that three basic types of ring galaxy can be distinguished: those with a prominent nucleus off center but within the ring; those characterized as "empty rings," that is, without a nucleus; and those with bright knots, presumably concentrations of stars or other luminous matter, on the ring itself.

The discovery of ring galaxies came as a surprise to astrophysicists because the ring is usually an unstable shape fo a large distribution of matter, unless there is a very massive object at its center. (Thus, Saturn's rings are relatively stable because they are centered on that massive planet.) Without such a central object, theory suggests that a ring is likely to break up, spin apart, collapse, or diffuse into space. Calculations for specific ring galaxies indicate that they cannot persist as rings fo much more than a hundred million years. Since most normal galaxies are at least ten billion years old, the observed ring galaxies must have bee created long after the normal galaxies came into existence. This, taken together with their unusual shape, migh mean that ring galaxies are also produced in a different manner from that o normal galaxies.

At first, theories advanced to explain the rings tended to concentrate on thei formation as new objects, somehow generated from a hypothetical gaseou medium in intergalactic space. Although we know that there is much ga in the interstellar space within spiral and other kinds of galaxies, there i little hard evidence on the properties o any possible gas in the space between galaxies. Theorists tended to concentrate on individual cases since rin galaxies were not generally recognize as a class of objects with common properties.

One of the pioneering studies wa made by E. Margaret Burbidge, an astronomer at the University of Califor nia, San Diego, who observed the mysterious Mayall's Object in May 1961. A photograph obtained with the 120-inc telescope at Lick Observatory i California showed that Mayall's Objec (named for a well-known astronomer consisted of a ring and a highly elon ted companion galaxy that Burbidge med the "cigar-shaped main body," ong with a faint luminous streamer, or idge, apparently connecting the ring d the cigar. Based on a study of the otograph and of spectrograms that e also made with the Lick telescope, rbidge was led to "propose tenta- ely that this object is an example of interaction between a galaxy and the ergalactic medium." By "galaxy" e meant the cigar-shaped body, as the ture of the ring seemed uncertain.

Several years after Burbidge's idea s published, more detailed theories re advanced that also accounted for g galaxies as products of encounters normal galaxies with intergalactic tter. According to one theory, a ring ormed from a vortex generated in the ke of a normal galaxy as it flies ough the intergalactic medium, ch as a vortex may occur near a large k in a shallow, swiftly flowing river. e normal galaxy, of course, would be ntified with the observed companion axy of the ring.

Another concept, which attracted ch more interest, was that ring axies "result from encounters of mal spirals with intergalactic . . . uds." This theory assumes that in- galactic matter consists of a clumpy tribution of clouds, rather than a ple, smooth medium. Advanced in 4 by astronomers at the Australian tional University and the University Texas, this proposal was the leading ory for a time. It is interpreted as uiring that intergalactic clouds be nposed of neutral hydrogen atoms, h properties that would render the uds readily detectable in sensitive io-astronomy surveys. Pertinent ob- vations have now been made with a)-foot-diameter radio telescope at een Bank, West Virginia. Although ousand regions of the sky have been died with this telescope, analysis of results reveals no support for the rgalactic cloud theory. Last year, Green Bank observer wrote to me radio emission from the clouds ould easily be seen" in his data if it sted, but that "we see nothing."

n addition to its shape, the most sig- cant characteristic of a ring galaxy / be the presence of the nearby com- ion. After studying a collection of galaxy photographs and taking ac- nt of likely effects due to perspec- , John Theys concluded that the panion is always located on or near "axis of symmetry" of the ring. In r words, if some cosmic giant were oke a finger straight through the

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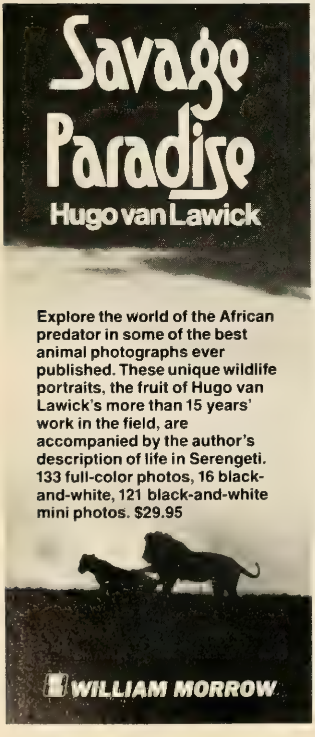

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Troubled Waters

KILLING THE HIDDEN WATERS, by Charles Bowden. *University of Texas Press, $9.95; 207 pp., illus.*

Moving southwest from New England to Baja California, a distance of some 2,500 miles, one passes from forest through grassland to desert. Rainfall decreases and evaporation increases along this gradient until the extremely arid climate of the desert is reached.

Until recently, population density was roughly proportional to the amount of available moisture. For centuries the sparse native population of the desert survived by strict adjustment to the harsh environment. Water scarce, people few; much water, many people.

In addition to the surface water of lakes, wetlands, and rivers, there are vast stores of water underground. These have been built up during the long geologic past. Where rainfall is abundant, these stores are continually recharged, replacing the water that escapes or is brought to the surface. Where rainfall is light, the rate of underground storage decreases correspondingly, until in the desert it becomes zero. Here the subterranean reservoirs are, like any mineral deposit, nonrenewable. Their content is correctly called "fossil water"; if drawn to the surface by pumps, it cannot be replaced. Rural and urban developments that depend upon it are living on borrowed time.

Such developments were virtually impossible until the advent of cheap fossil fuel and the internal combustion engine, although there were a few remarkable instances of deeply dug wells in ancient times. Once deep drilling and pumping began, early in the present century, change followed fast: irrigated farms; urban centers to serve and be served by them; then large cities to accommodate refugees from harsh winters, wishing to bask in desert sunshine.

Less noticed were the well-meant efforts of the Bureau of Indian Affairs to ease the laborious life of the desert Indians by furnishing them with deep-drilled wells equipped to supply abundant water. Thus, abruptly, the whit man's ideal of minimizing physical effort was imposed upon an ancient highly disciplined pattern of adaptatio to the limitations of desert climate.

Essentially, this is the story told b Charles Bowden, project coordinato for the Radio-Television-Film Burea of the University of Arizona, in hi book *Killing the Hidden Waters*. But s unusual, effective, and important is hi manner of telling, that a fair amount o background seems justified.

Too little known and almost completely ignored in public policy is quiet revolution in the professiona study of human societies. With rare exceptions, such as Marco Polo, observers of alien societies have generall looked upon them as something abnormal, the standard of measuremen being the society of the observer. Thi attitude weakened any scruples abou exploitation, enforcement of viole change, or even extermination. One i reminded of the reply of a rustic chide for shooting a pelican many miles outside of its range. "Shoot it, course shot it. I never seen such a damn thin before."

Gradually, and not too long ago, students of mankind began to adopt a ne working assumption. In effect, thi amounted to saying, "Suppose that instead of regarding ways of life oth than our own as abnormal or eve pathological curiosities, we treat the as legitimate entities in their own righ each with its own internal logic, making sense to its members, and to b understood, so far as possible, fro within."

A century earlier the science of geology became possible when geologis adopted the idea that past changes ha been due to the same forces that opera today. In similar fashion, the students human societies found a powerful to in their new working assumption. Th old idea of folkways (which had emphasized differences) was modified by Paul B. Sears

monstrate a quality common to all oups, namely the tendency to develop tterns of behavior, and values to reforce them, that fitted both the resurces of each environment and its mpelling limitations.

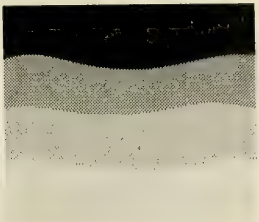
This means that each culture pattern not a fixed thing, but a process. If it sults in a viable relationship with enonment, the group survives. If not, experiment fails. Meanwhile, the erations of the group are reinforced value systems expressed in belief, ual, and the arts. Thus, what works mes to seem right, and what seems ht becomes right.

This idea, of course, is like a red rag those who insist on an absolute code right and wrong applying universally all of mankind. Yet the late Justice iver Wendell Holmes, through his dy of the common law and the losophy of law in general, arrived at essential idea of the culture pattern. e morning as he and Judge Learned nd were parting on their separate ys to work, Holmes turned half angly on his friend Hand, who had bade n go and dispense justice, saying, "I 't dispense justice. All I can do is to and see that the game is played acding to the rules." Obviously, the es must vary as do the conditions that e shaped the various cultures.

Not only is each culture pattern ely a response to environment but beliefs and values determine its tment of environment. Thus, any roach to environmental problems st reckon with the culture patterns olved. The conventional approach insists "there ought to be a law" or divides a society into the righteous the evil on this issue is too naïve, med to fail.

o an extent unique in my experie, and with rare insight, Charles vden analyzes the human adven-, past and present, within the great thwestern desert. Introducing the ure of the Papago, he tells of the hed stick that serves as a record. ring parallel events of the white

Killing the Hidden Waters



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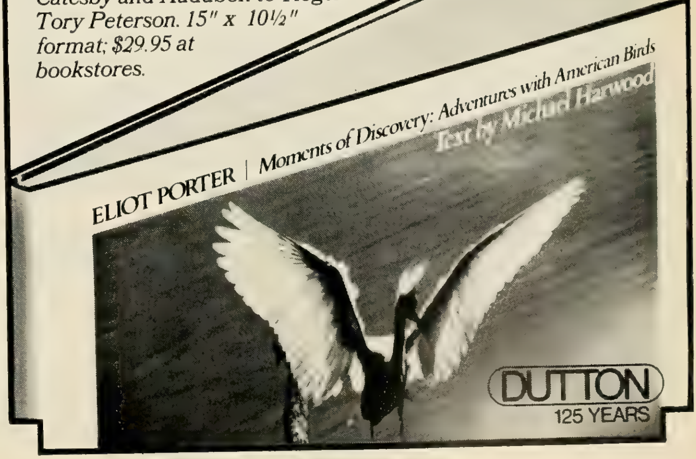
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Troubled Waters

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Moving southwest from New England to Baja California, a distance of some 2,500 miles, one passes from forest through grassland to desert. Rainfall decreases and evaporation increases along this gradient until the extremely arid climate of the desert is reached.

Until recently, population density was roughly proportional to the amount of available moisture. For centuries the sparse native population of the desert survived by strict adjustment to the harsh environment. Water scarce, people few; much water, many people.

In addition to the surface water of lakes, wetlands, and rivers, there are vast stores of water underground. These have been built up during the long geologic past. Where rainfall is abundant, these stores are continually recharged, replacing the water that escapes or is brought to the surface. Where rainfall is light, the rate of underground storage decreases correspondingly, until in the desert it becomes zero. Here the subterranean reservoirs are, like any mineral deposit, nonrenewable. Their content is correctly called "fossil water"; if drawn to the surface by pumps, it cannot be replaced. Rural and urban developments that depend upon it are living on borrowed time.

Such developments were virtually impossible until the advent of cheap fossil fuel and the internal combustion engine, although there were a few remarkable instances of deeply dug wells in ancient times. Once deep drilling and pumping began, early in the present century, change followed fast: irrigated farms; urban centers to serve and be served by them; then large cities to accommodate refugees from harsh winters, wishing to bask in desert sunshine.

Less noticed were the well-meant efforts of the Bureau of Indian Affairs to ease the laborious life of the desert Indians by furnishing them with deep-drilled wells equipped to supply abundant water. Thus, abruptly, the white man's ideal of minimizing physical effort was imposed upon an ancient, highly disciplined pattern of adaptation to the limitations of desert climate.

Essentially, this is the story told by Charles Bowden, project coordinator for the Radio-Television-Film Bureau of the University of Arizona, in his book *Killing the Hidden Waters*. But so unusual, effective, and important is his manner of telling, that a fair amount of background seems justified.

Too little known and almost completely ignored in public policy is a quiet revolution in the professional study of human societies. With rare exceptions, such as Marco Polo, observers of alien societies have generally looked upon them as something abnormal, the standard of measuremen being the society of the observer. Thi attitude weakened any scruples abou exploitation, enforcement of violen change, or even extermination. One i reminded of the reply of a rustic chide for shooting a pelican many miles ou side of its range. "Shoot it, course shot it. I never seen such a damn thin before."

Gradually, and not too long ago, stu dents of mankind began to adopt a ne working assumption. In effect, th amounted to saying, "Suppose that i stead of regarding ways of life oth than our own as abnormal or eve pathological curiosities, we treat the as legitimate entities in their own righ each with its own internal logic, ma ing sense to its members, and to understood, so far as possible, fro within."

A century earlier the science of ge ogy became possible when geologis adopted the idea that past changes h been due to the same forces that opera today. In similar fashion, the students human societies found a powerful t in their new working assumption. T old idea of folkways (which had e phasized differences) was modified

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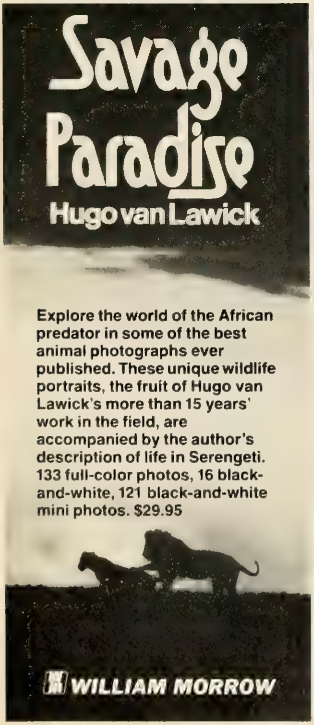

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by Paul B. Sears

emonstrate a quality common to all roups, namely the tendency to develop atterns of behavior, and values to re- force them, that fitted both the re- urces of each environment and its mpelling limitations.

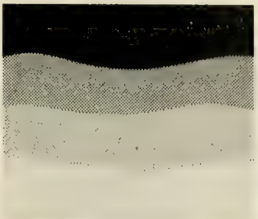
This means that each culture pattern not a fixed thing, but a process. If it sults in a viable relationship with en- ronment, the group survives. If not, e experiment fails. Meanwhile, the erations of the group are reinforced value systems expressed in belief, ual, and the arts. Thus, what works mes to seem right, and what seems ht becomes right.

This idea, of course, is like a red rag those who insist on an absolute code right and wrong applying universally all of mankind. Yet the late Justice iver Wendell Holmes, through his dy of the common law and the losophy of law in general, arrived at essential idea of the culture pattern. e morning as he and Judge Learned nd were parting on their separate ys to work, Holmes turned half an- y on his friend Hand, who had bade go and dispense justice, saying, "I 't dispense justice. All I can do is to and see that the game is played ac- ling to the rules." Obviously, the s must vary as do the conditions that e shaped the various cultures.

ot only is each culture pattern ely a response to environment but beliefs and values determine its ment of environment. Thus, any oach to environmental problems t reckon with the culture patterns lved. The conventional approach insists "there ought to be a law" or divides a society into the righteous the evil on this issue is too naïve, ned to fail.

an extent unique in my experi- , and with rare insight, Charles den analyzes the human adven- past and present, within the great western desert. Introducing the re of the Papago, he tells of the ied stick that serves as a record. ing parallel events of the white

Killing the Hidden Waters



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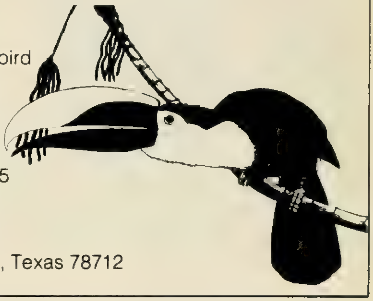

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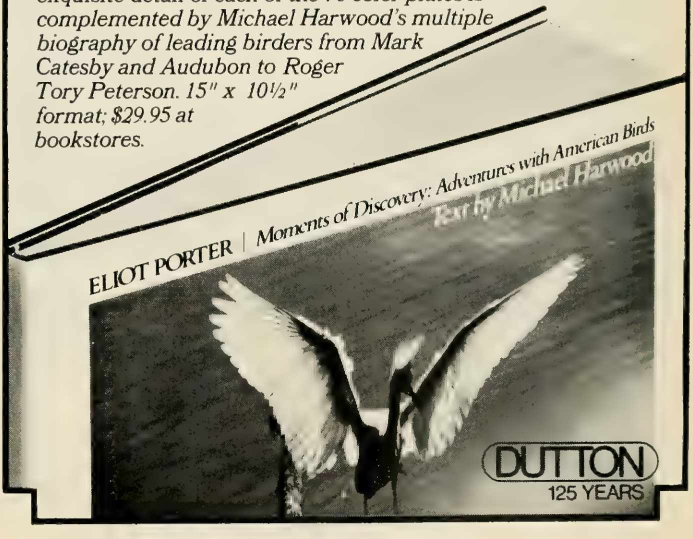
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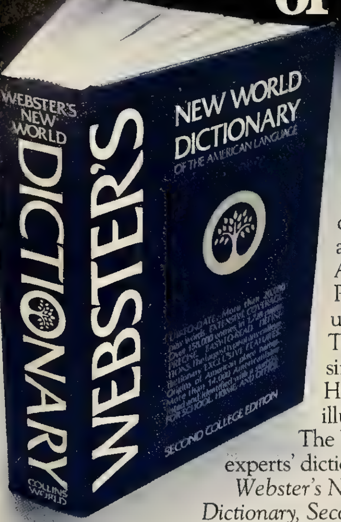

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man's world, such as the Mexican Wa and the Gold Rush, this chronicl notices the changing phases of the seasons, climatic vagaries, and othe events of significance to the Indians Toward the end, it records the killing o a tribesman by a white man's automobile and the drilling of a well i 1912 by agents of the government.

In almost symphonic form we ar made aware of the grim but viable regimens that enabled the riverine Pim of the Gila Valley, the desert O-otam and the Sand Papago farther west t survive. The Pima grew cotton an food crops by virtue of miles of ditches constructed by such primitive mean that the first shovel seemed like miraculous object. Away from the Gil River, life was sustained by carryin water, often for distances of severa miles; by moving about to take advantage of the seasonal yields of dese plants; and where possible, by gathe ing food from the seashore. I have see mute evidence of this way of life: *man* and *metate* for grinding seeds—a though left yesterday—in a cave c Tiburón Island on the Gulf of Califo nia and shell heaps devoid of artifac along the shore of the Sea of Cortés.

Querulous critics of the "Purita work ethic" could do worse than po der the account of the uncompromisi code of the desert people, obliged bring water, plant and tend gardens, a harvest native sources of food as th became available, all at distances miles and by foot travel. Unquestioni acceptance of unremitting toil was t basic virtue, as was courage for t Spartan. Along with this went devoti to whatever ritual was needed to insu favorable conditions and, as transl tions show, genuine poetical feelin Supporting both effort and belief w an amazing knowledge of desert r sources.

Our generation, which blissfully i nores the succession of round tri through the human alimentary syste made by river water flowing past c great cities, has little cause to look w contempt on the "second harvest" the desert people—the retrieval of u digested seeds from excrement for u in times of extreme need. But strang to hunger as we are—too oft overfed—we might be entitled to so qualms in witnessing a child snatch and eat a newborn puppy as though were a freshly plucked fruit.

If there is any way other than cr hardship and necessity for changing trend of a human society, I suspect it l in drama. And by his insistent portra

f the traditional culture that made sur-
ival possible without exploiting the
onrenewable resources of the south-
vestern desert, Bowden has furnished
he structure upon which to dramatize
vhat follows. For this is an account of
he illusory riches suddenly made
vailable by using nonrenewable fuel to
xploit nonrenewable water. Instead of
perating on the current budget of en-
rgy and materials, the farms and cities
f the Sunshine Belt are living upon the
ccumulation of ages, consuming in
ecades what it took millions of years to
tore.

Even now this spectacular example
f technology is beginning to digest its
wn tissues in order to keep going. One
f the greatest of its urban centers is
uying up the water rights of the irri-
ated farms that spread beyond its bor-
ers, thus ending whatever wealth
ight be created by solar energy acting
pon green plants by grace of a limited
pply of surface water. Predictably, as
is self-cannibalism progresses, there
pressure for relief by an expanded
chnology, drawing upon increasing
nounts of energy and resources from
yond the desert boundaries.

Invoking the inexorable laws of
ermodynamics, and pointing out that
ent and dispersed resources disadvan-
ge the future, the author concludes:
This writing has always been on the
all. It is not a revelation to learn that
eap energy makes societies boom,
at groundwater in arid regions has
gligible recharge, that humans tend
use as much of anything as they can
y their hands on. We can ignore these
cts and pump, mine and combust [*sic*]
th abandon, or we can recognize
se facts and attempt to construct a
stainable society. There will be no
inless answers, nor were there any in
past."

Which suggests something too often
erlooked. Cultures establish them-
ves by learning to use the resources
their environments. They persist by
rning to respect the limitations of
se environments. Our own has more
n met the first of these conditions.
e increasing pressure on clean air
l water, minerals, building mate-
ls, living space, and energy are grim
ninders that we have yet to face the
ond — our limits.

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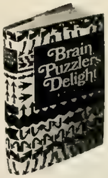

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Announcements

The new **Hall of Reptiles and Amphibians** will open on Friday, November 18. Containing ten large exhibits, the hall is one of the most complete presentations on the distribution, behavior, physiology, and evolution of reptiles and amphibians. It is expected to be one of the Museum's most popular permanent halls and is located on the third floor, Theodore Roosevelt Memorial Building, Central Park West. For further details please see page 98.

In conjunction with the above, the Museum library, fourth floor near the 77th Street elevators, will display some rare illustrated books on reptiles and amphibians. Included in this **Rare Book Exhibit** will be an important sixteenth-century treatise on natural history written by Conrad Gesner; an early nineteenth-century first printing of an important tractate on Brazilian natural history by Johann Baptiste de Spix; and one of the first and most important books on North American herpetology, written in the mid-nineteenth century by James Holbrook.

On November 10 at 8:00 P.M. in the Museum auditorium there will be a slide lecture on the **New Alchemy Institute** presented by its cofounder John Todd, an agriculture scientist and marine biologist. The New Alchemy Institute, located near Woods Hole, Massachusetts, was established in 1969 to explore the possibilities of solving the world food shortage problem by creating small, self-contained, ecologically balanced units that would use wind and solar power to recycle water and nutrients. Tickets for associate members and the public are $2.00 an
will be available at the auditorium doo
half an hour before the program begins
Participating and donor members wil
be admitted free.

The African Elephant, filmed an
directed by Simon Trevor, will b
shown on December 1 at 8:00 P.M. i
the Museum auditorium. Nearly tw
hours long, the film tells the life story o
these intelligent, gentle, and mysteri-
ous creatures from birth (after a 22
month gestation period), through dail
life in the highly organized society o
the herd, to eventual death. Dr. Richar
Van Gelder, curator in the Museum'
Mammalogy Department, will lead
discussion following the screening.

Tickets, available at the door one
half hour before the program begins
are $2:00 for associate members an
the public. Participating and donc
members will be admitted free. All pe
sons attending this program shoul
enter through the lower-level drivewa
entrance on Central Park West.

Peru's Golden Treasures will re
main on view in Gallery 77 on th
Museum's first floor through January
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dition. Gloves, small figures, drinkin
beakers, a litter backrest, crowns, ce
emonial blades, and burial masks, a
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Additional Reading

Naked Mollusks (p. 46)

Alan Solem's *The Shellmakers: Introducing Mollusks* (New York: John Wiley and Sons, 1974) provides an introduction to this whole group of animals and places slugs in their proper context. Papers dealing with slugs and other gastropods appear most regularly in three biological serials devoted to the Mollusca: *The Nautilus* (published by the Delaware Museum of Natural History, Greenville), *The Journal of Molluscan Studies* (published by the Malacological Society of London), and *Malacologia* (published by the Institute of Malacology, Ann Arbor). While aggression in terrestrial slugs had not been seriously considered prior to the Rollo and Wellington study, aggressive reactions in a marine gastropod were recently described in S. Zack's "A Description and Analysis of Antagonistic Behavior Patterns in an Opisthobranch Mollusc, *Hermissenda crassicornis" (Behavior,* 1976, pp. 238–67). Readers interested in the classification of slugs or in faunal lists should consult Henry A. Pilsbry's "Land Mollusca of North America North of Mexico" (Monograph of the Philadelphia Academy of Natural Sciences, 1948, pp. 521–1113). C. D. Rollo and W. G. Wellington have listed the kinds of slugs to be found in the lower mainland of British Columbia in "Terrestrial Slugs in the Vicinity of Vancouver, British Columbia" (*The Nautilus,* 1975, pp. 107-16).

Walruses (p. 52)

The World of the Walrus, by Richard Perry (New York: Taplinger Publishing Co., 1968), is enriched by an extensive bibliography. This general history of walruses focuses on their biology, their behavior, and their exploitation by humans. The yearly rhythm of Arctic animals is treated most fully by Peter Freuchen and Finn Salomonsen in *The Arctic Year* (New York: G. P. Putnam Sons, 1958). This popular work, illustrated with line drawings, gives extensive coverage of the walrus. Francis H. Fay and Carleton Ray have reported on their studies in volume 53 (1968), of *Zoologica,* which is published by the New York Zoological Society. The tw articles are "Influence of Climate on th Distribution of Walruses, *Odobenu rosmarus* [Linnaeus]: I. Evidence fro Thermoregulatory Behavior (pp. 1–1 and II. Evidence from Physiologic Characteristics" (pp. 19–32). Both se tions deal with thermoregulatory cause for walrus huddling behavior. Fay als discusses rogue walruses as disea bearers in "Carnivorous Walruses an Some Arctic Zoonoses" *(Arctic,* Ju 1960, pp. 111–22). Gavin Maxwell *Seals of the World,* published in 1967 b Houghton Mifflin, Boston, includ detailed descriptions of all seal speci as well as information on exploitati and biological subjects.

For other general biological a physiological treatments of the pi nipeds, please see last month's "Add tional Reading."

Forest Ecology (p. 62)

Peter Farb's profusely illustrat book *The Forest,* a part of the "Li Nature Library" series, contains su chapters as "The Web of Forest Lif and "The Hidden World of the Soil *The Great American Forest,* by Ruthe ford Platt (Englewood Clif Prentice-Hall, 1965), a scholarly b readable natural history, contains d tailed information about forest ecos tems. For an in-depth account of t work done by Likens, Bormann, et a the reader may consult a paperba published by Springer-Verlag of N York in 1977, *Biogeochemistry of Forested Ecosystem,* written by th with Robert S. Pierce, John S. Eat and Noye M. Johnson. Three wo deal effectively with water as an act physical component of an ecosyst *Fluvial Processes in Geomorpholo* by Luna B. Leopold, M. Gord Wolman, and John P. Miller (San Fr cisco: W. H. Freeman, 1964) is a p cise explanation of such processes erosion and river formation. Sligh less technical is Luna B. Leopold's *ter: A Primer* (San Francisco: W. Freeman, 1974). K. J. Gregory and E. Walling's *Drainage Basin Form Process: A Geomorphological* ach (New York: Halsted Press/John ley, 1973, $12.50 in paperback) de-ibes such characteristics of a drain- basin as landscape, vegetation, and k in terms of erosional processes. It nonstrates ways of measuring pre-itation, erosion, and water balance. do Leopold's eloquent *Sand County nanac* (Westminster: Ballantine oks, $1.95) has line drawings by arles W. Schwartz and includes sec-ns on land conservation, erosion, l wilderness.

ld Sheep (p. 72)

A recent *Natural History* article on d goats of the west coast is Bruce E. blentz's "Wild Goats of Santa alina" (June/July 1976, pp. 70–77). *untain Sheep: A Study in Behavior l Evolution*, by Valerius Geist icago: University of Chicago Press, 1), is based in part upon the author's D. dissertation field work on erican species from 1961 to 1966. s book, available for $7.95 in erback, includes seventeen pages of iography and refers the reader to sources for further study of the avior of mountain sheep. Black--white photographs illustrate spe- behaviors and settings. James L. k's *The Great Arc of the Wild Sheep*, lished in 1964 by the University of ahoma Press, Norman, is a less sci-fic work that describes these ani-s species by species. It is based both he literature and on Clark's own ing experiences. Clark was an ar- and the reader's visual curiosity it each animal is at least partly fied by illustrations of mounted imens and by pictures of museum amas. The reader might also enjoy ing at Richard Lydekker's *Wild , Sheep and Goats of All Lands, g and Extinct* (London: R. Ward, , 1898). This work is only available arger research or university li-es, but is beautifully illustrated and h the effort involved in locating it. e is a copy in the library of the rican Museum of Natural History. most complete recent book on in the New World is edited by James B. Trefethan, and entitled *The Wild Sheep in Modern North America*. This work, the printed proceedings of a workshop on the management biology of North American wild sheep, was sponsored by the Boone and Crockett Club, the National Audubon Society, and the Wildlife Management Institute. It was published in 1975 by the Boone and Crockett Club with Winchester Press, New York, and is available in paperback for about $10.00.

Street Dwellers (p. 78)

A recent article dealing with New York's shopping-bag people is Joan Roth's photographic essay, "If I'm Not on My Milk Crate, You Can Find Me in My Phone Booth," in the March 1977 issue of *Ms.* (pp.74–77). The *New York Times* of September 30, 1976 (p. 43), published an article by Molly Ivins about one woman's return to "normal" living. An entire issue of the women's newspaper *Majority Report* (October 17, 1974) was devoted to the subject of shopping-bag women with several articles by Beverly Burlett, some based on participatory observation.

Although there is no body of scientific literature to deal with the subject of street dwellers, the following material may be relevant to the subject. First, there is the classic work by Joseph A. Singh and Robert M. Zingg, *Wolf-Children and Feral Man* (Hamden: Shoe String Press, 1966), about cases of so-called wolf children who may have been raised by wild animals without human companionship. In "Feral Man and Extreme Cases of Isolation" *(American Journal of Psychology,* 1940, pp. 487–517), Zingg suggests that isolation from other humans may cause some of the symptoms shown by these people. Two well-known studies of street people are William Whyte's *Street Corner Society: The Social Structure of an Italian Slum* (Chicago: University of Chicago Press, 1955) and *Talley's Corner,* written in 1967 by Elliot Liebow (Waltham: Little, Brown & Co.), and available in paperback.

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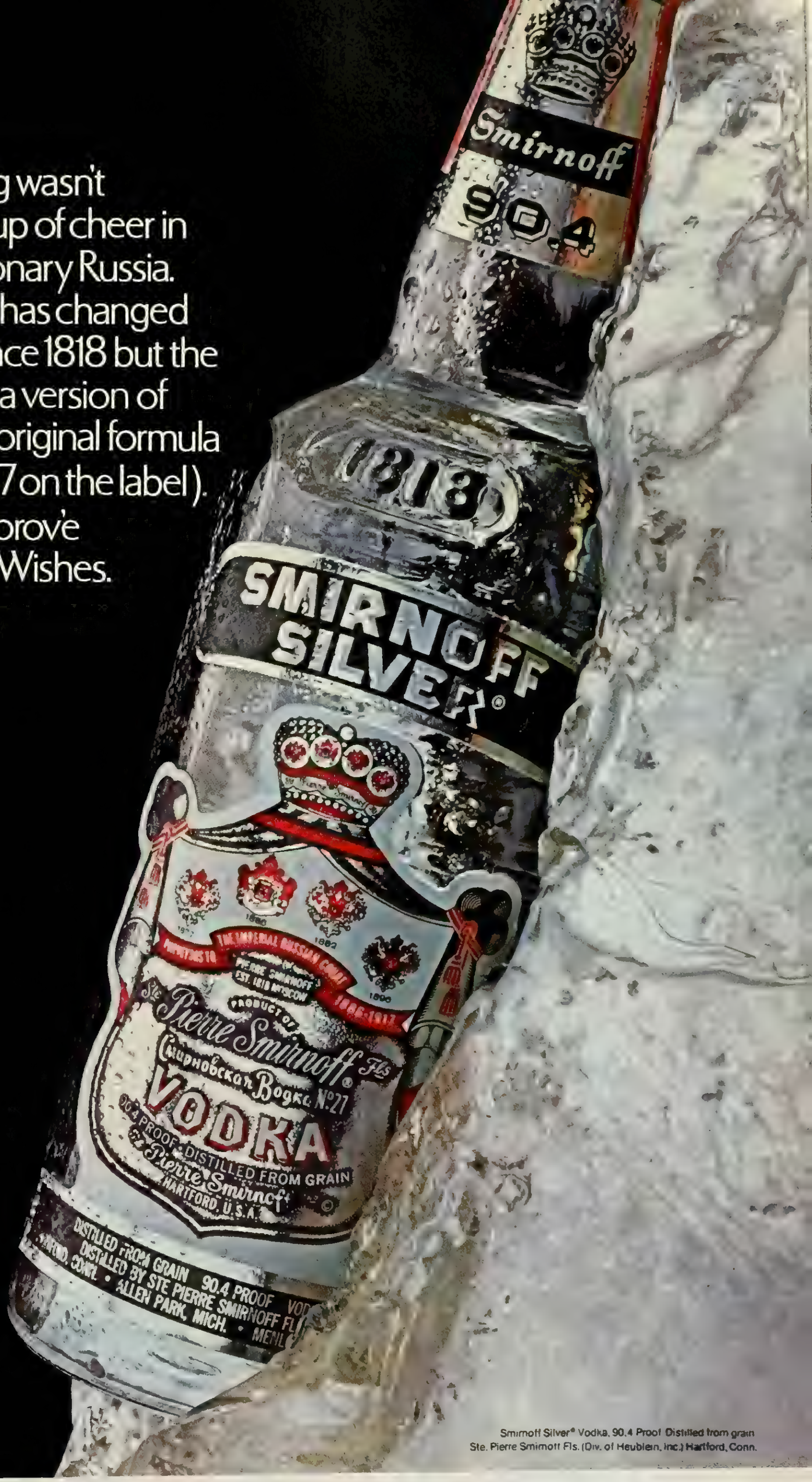
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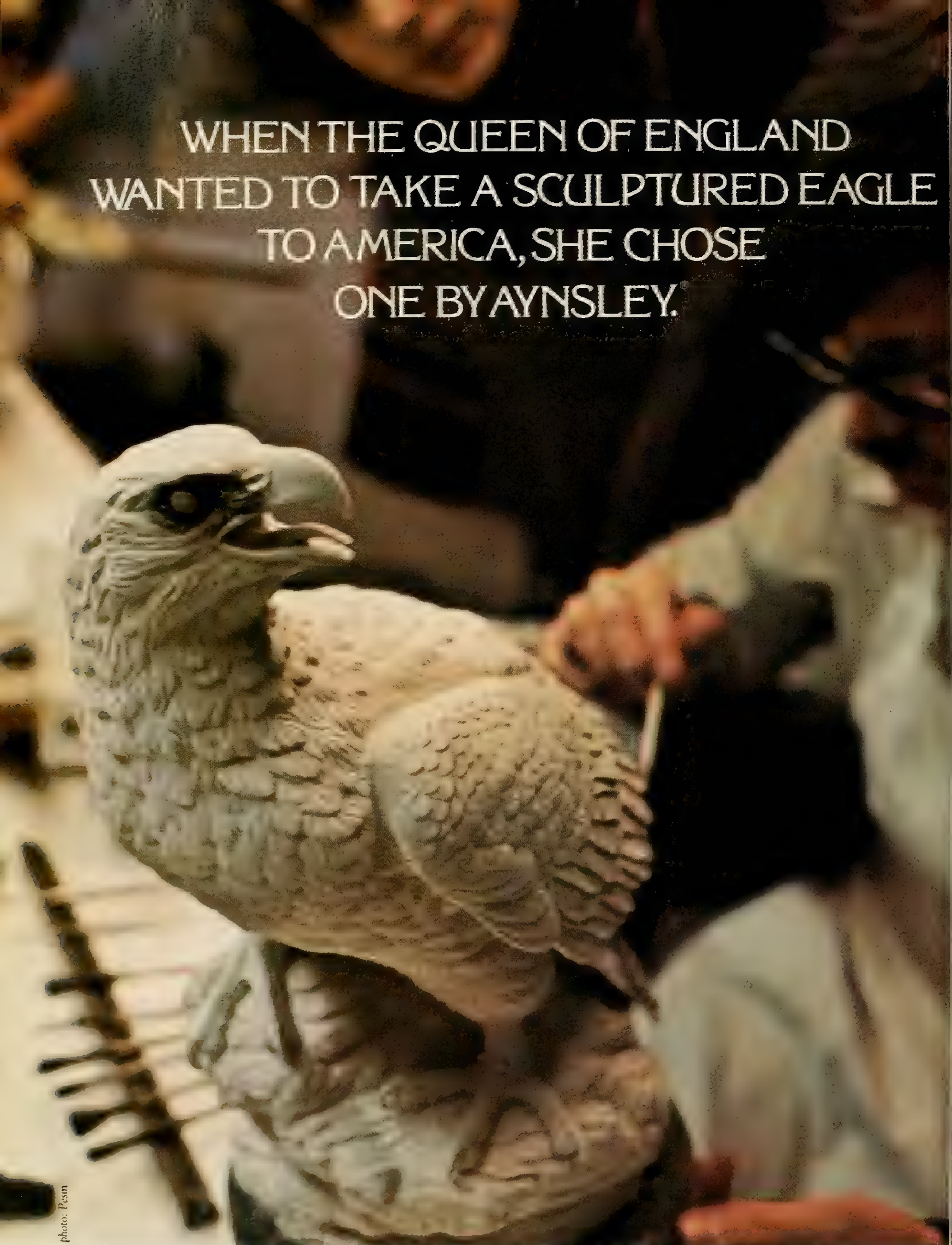
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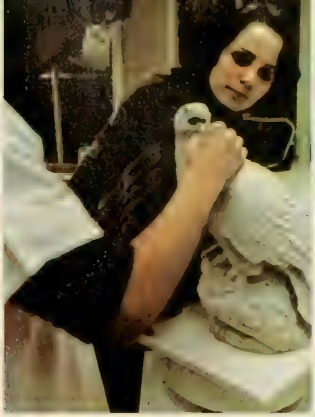

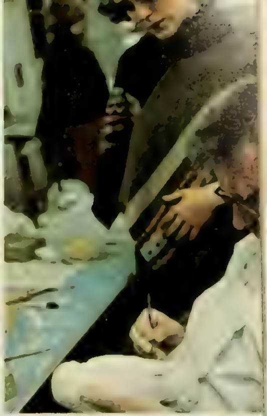

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Centuries before European sailors ventured forth, giant Chinese ships roamed the oceans.

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A modern city wreaks havoc on most tropic flora, but a few modest plants manage to make it.

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In springtime—early December—the chicks hatch and form crèches of hundreds of birds.

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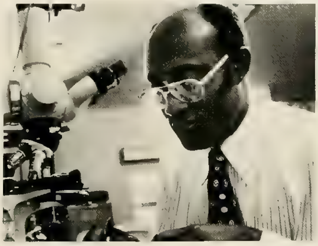
Cover: *Children on the Faeroe Islands spend the summer hours bicycling up and down the streets of their isolated villages. Each village has its own sweater design. Story on page 40. Photograph by Michael Spring.*

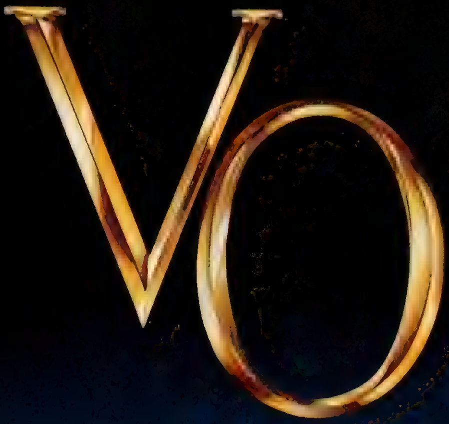
Authors



Dwindling supplies of firewood in developing countries alerted **Edward S. Ayensu** to the importance of fast-growing eucalyptus trees, which are widely used as a fuel source. His knowledge of the subject led him to head a panel on firewood energy resources held earlier this year by the National Academy of Sciences. A botanist by training, Ayensu is the director of the Smithsonian Institution's Endangered Species Program and secretary-general of the International Union of Biological Sciences. He wrote "Beautiful Gamblers of the Biosphere," for the October 1974 issue of *Natural History*. New York-born **Gail Rubin** is now living in Israel. Through her work as a free-lance nature photographer, she became aware of the subtle color changes in that country's arid regions and is now studying this phenomenon in the Sinai Desert.

A professional writer living New Mexico, **Stan Steiner** is n in Venezuela, where he is studyi the cultural, ecological, and pol cal changes that rural people o developing country undergo wh oil is discovered on their lands a they begin working in oil fields a industry. Steiner's article on t prowess of ancient Chinese m iners is taken from the last i series of four books he has co pleted on non-European, nonwh peoples who have contributed the character of contempor America. Steiner previously wrot special supplement for *Natural H tory*, "The Waning of the Wes which appeared in the June/J 1975 issue.

When **John F. West** first visited the Faeroe Islands in 1956, he immediately felt at home because the villages reminded him of those in his native England. Since then, he has returned to the islands seven times. West, who lectures at Trent Polytechnic in Nottingham, England, has spent many years studying the history and literature of the Faeroes and has written a history of the islands, *Faroe: The Emergence of a Nation*. Photographer **Michael Spring** went to the islands to find peace and quiet in which to write a play. The beauty of the islands, however, proved a greater distraction than the bustle of New York, where he wears still another hat as editor of *Literary Cavalcade*, a Scholastics Magazines publication.



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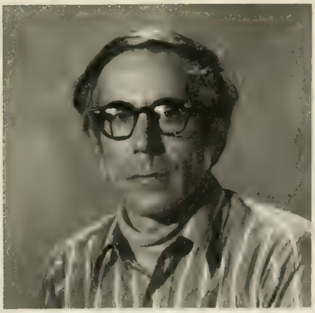
Until the end of November, en he returned to his native New rk State, **Peter Bernhardt** taught any at the National University El Salvador in San Salvador, der the sponsorship of the Peace rps and the Smithsonian Institun's Environmental Program. rnhardt's prime botanical inest is pollination ecology of hightude tropical terrestrial herbs. hough he had never felt drawn orchids before his arrival in El vador, he found that the more n 290 local species were "hard ignore even if I wanted to." rking in conjunction with the ithsonian Institution on orchid tection and propagation, he has t seeds of more than fifty spes of both common and extremely e Salvadoran orchids to Washton for cultivation.

A consulting geologist for Fondo Nacional Exploración Minera, an agency of the Bolivian Government, **Juan Muñoz** is exploring the hinterland of that country in search of tin deposits. While on a similar expedition in 1971—in search of fluorite in the Patagonia region of Argentina—he came across the nesting islands of the Chilean flamingo near the village of Colán Conhué. Three years of intermittent observation and filming of the bird's reproductive activities followed. As a geologist, Muñoz has trekked through many of the less accessible reaches of North and South America, giving him the opportunity to pursue his twin avocations of wildlife study and pre-Columbian archeology.



ames H. Shaw conducted one of first ecological and behavioral dies of the endangered red wolf he early 1970s. An assistant prosor of biology at Oklahoma State iversity, he is now working on taxonomy, ecology, and socionomic status of coyotes. Other earch in progress includes a dy on elk ecology and fieldwork the red fox. Coauthor **Peter A. Jordan** is associate professor in the Department of Entomology, Fisheries, and Wildlife at the University of Minnesota. His recent research has centered on the impact of moose on forest vegetation and aquatic ecosystems. He has also studied wolves on Isle Royale, in Lake Superior, as part of Durward Allen's long-term program on that island.

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by Robert S. Desowitz and Louis H. M

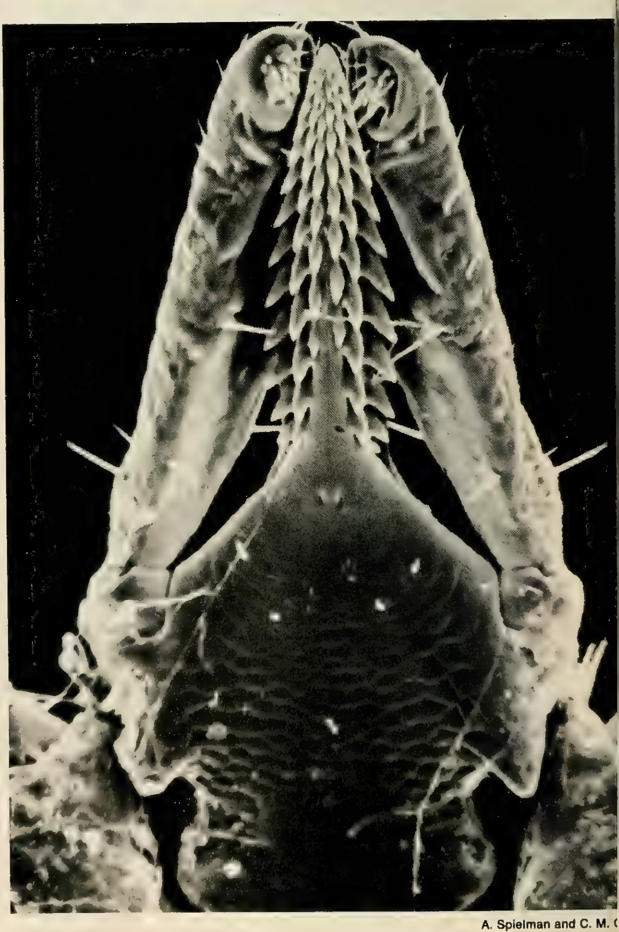
Dangerous Nymphs of Nantucket

In the wake of major ecological changes, a small arthropod has begun to transmit a serious disease to this island's upper crust

The rich are not like you and me. They summer on Nantucket and get babesiosis, hardly a household word in the almanac of human ailments. Not readily recognized by the infectious disease pundits or hotly pursued by the parasitologist, this low-class, malarialike parasite of rodents has come to plague the residents of that idyllic Massachusetts island.

Babesia parasites have long been known, particularly for infecting domestic stock. In the warm, arid climate of Australia, and at one time in Texas, babesiosis resulted in enormous economic loss to the cattle industry. And before the outbreaks on Nantucket, four well-documented cases had occurred in humans, the first of which was discovered in Yugoslavia in 1957. In each of these cases, however, the infected individuals were immunologically deficient. All of them had previously had their spleens removed, an operation that weakens one's immune defense system. Generally speaking, however, these animal parasites were considered incapable of making the enormous leap to humans. But on Nantucket Island in 1969 they crossed the barrier. The list of epidemiological-ecological ingredients that made this situation possible reads like the contents of a witch's caldron—sheep, deer, mice, ticks, *Babesia* parasites, bayberry, and scrubland.

From this brew emerged the evil genie that was to possess a long-time summer resident of Nantucket Island. The patient had enjoyed remarkably good health for most of her 59 years, but in July 1969, she found herself in a New Brunswick, New Jersey, hospital. Two months earlier, had closed her home in Santa bara, California, to make her an summer pilgrimage to Nantuc where she owned a pleasant es in a scrubland area near the Early in July, she began to s from a high fever, abdom cramps, and a depressed state. spite a battery of medical tests cause of her ailment did not c



The Ixodes scapularis *nymph (magnified 247 times) feeds on the blood of rodents and humans by penetrating the skin with formidable mouthparts.*

A. Spielman and C. M. C

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to light. The fever persisted, the depressed state worsened, and the woman felt the will to live slipping from her.

A New Jersey physician vacationing on Nantucket persuaded the ill woman to enter the hospital he was affiliated with, where, in addition to her other symptoms, she was found to be suffering from pronounced anemia. Chance now intervened. A technician employed in the hospital laboratory, who had served in the Army Medical Corps in Vietnam, noticed forms in the patient's blood that were remarkably similar to the malaria parasites he had seen in Vietnam. The patient, however, had never traveled in the tropics and Nantucket is hardly an area of endemic malaria. The stained blood smear was then air-mailed to the Center for Disease Control in Atlanta, where parasitologists provisionally identified the parasite as a species of *Babesia*.

The annals of medical literature are studded with reports of infectious oddities: rare and often bizarre instances of alien pathogens infecting humans. Was this an example of one of these isolated cases or did the woman's infection herald a true zoonosis—a disease of animal parasite origins? The answer began to appear four years later when a second person from Nantucket was diagnosed as having babesiosis. In 1975 seven more cases were reported from the island and during the summer of 1976 another five vacationers were infected. At the time, a zoonotic outbreak of babesiosis seemed to have struck Nantucket; however, no new cases have appeared this year.

There are various species of *Babesia*, all containing a wisp of cytoplasm and a minute dot of nucleus. Within the red blood cell, they appear deceptively similar to *Plasmodium falciparum*, the malignant tertian malaria organism. Indeed, considerable parasitological connoisseurship is required to distinguish between the two kinds of parasites. This morphological similarity has led to a diagnosis of malaria in some patients suffering from babesiosis.

Within the red blood cell the *Babesia* parasite divides asexually once or twice. The cell then disrupts, releasing the parasites, which proceed to invade new host red blood cells. Not all the pathogenic mechanisms associated with babesiosis are fully understood, but anemia, due to continuing red blood cell destruction, is a hallmark of the untreated infection. Another symptom in humans is severe depression. Whether this is caused by a chemical reaction to the parasite is not known.

Unlike the malaria parasite, which is transmitted by mosquitoes, the obligatory vector of *Babesia* is the tick, that grotesque arthropod that dog owners soundly curse each time their animals return from wandering in the underbrush. The *Babesia* reproduce within the tick but this phase of their biology is not well known, mainly because their unisex appearance has made scientific spectatorship difficult. Researchers do know that the tiny wormlike offspring first invade the tick's epithelial cells, undergo division, and finally invade the salivary glands. When the tick next feeds, the parasite is capable of infecting a warm-blooded host.

The gaps in our knowledge of *Babesia* biology illustrate the occasional slow pace of scientific progress. In 1893, T. Smith and F. L. Kilbourne, two Americans studying cattle babesiosis in Texas (where it is commonly called red water fever) determined that the parasite was transmitted by the tick. The discovery that a parasite of warm-blooded animals could, indeed must, jump the biological gulf to develop in the cold blood of invertebrates in order to effect transmission boggled the scientific community.

Those who have suffered tick bites or attempted to dislodge a tick's mouthparts tenaciously buried in their skin would agree with Aristotle's complaint that ticks are "disgusting parasitic animals." They belong to the Arachnida, a class of arthropods that includes the spiders and mites. To survive, grow, and reproduce, ticks must drink the blood of their hosts. Most species partake of this sanguine diet by a kind of movable feast. After hatching from the egg, the small six-legged larva attaches itself to, and feeds on, a host, then molts to an eight-legged, sexually immature nymph (a term coined by an entomologist with a particularly mordant wit). The nymph contin feeding on the same host until ad hood, when it switches to a seco usually larger host species.

Between meals, most species drop from their hosts either hide on the ground or c to vegetation and await a new h In temperate regions, adults immature stages of ticks can o winter and will renew their sea for a suitable host in the war of the late spring sun. Like vi ally all other bloodsucking art pods, each tick species posse genetically programmed idios cracies and restrictions as to h tat and host preferences. Whet a particular species can coloni particular ecological niche depe to a great extent on its ability withstand desiccation.

So much for the biology less The diagnosis and subsequ escalation in the number of clin cases of human babesiosis on N tucket resulted in the mobil tion of an army of experts. Sci tists from the Center for Dise Control, the Harvard School Public Health, and the Laborat of Parasitic Diseases of the tional Institutes of Health floc to Nantucket to begin the detect work to determine the causat factors and extent of infection humans and animals. The appro they took to understanding *Babesia* outbreak was an exam of how the exotic arts of the lab tory and the enigmatic arts of demiology can work in tandem.

Before the outbreak on N tucket, babesiosis had never b considered a significant threat public health since only those were immunologically com mised by lack of a spleen appea to be susceptible. But the pe on Nantucket who had come d with the disease were healthy, mal individuals prior to infecti That this did not fit the patter the European experience gave to the suspicion that another, yet unidentified species of *Bab* was involved in Nantucket.

Thus the first priority was to termine the species of para Fortunately for the investigat the patients continued to s parasites in their blood des chemotherapy and the abateme their clinical symptoms. Bl from these patients was inn lated into a variety of labora

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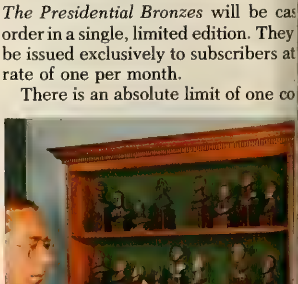

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animals. Three weeks later
besia parasites appeared in
blood of experimentally infec
hamsters. A monkey also beca
infected. The species was ide
fied as *Babesia microti,* a para
commonly found in certain
rodents throughout almost the
tire temperate zone of the wo
What had happened? Was the N
tucket *B. microti* a mutant
dowed with an ability to infec
broader host range than its par
strain? Or had a peculiar ass
blage of conditions brought m
tick, parasite, and rodent host
gether in such a way as to fa
tate human infection?

An attempt was made to ans
these questions by analyzing
B. microti species. Scientists t
compared the character of the
enzymes from different *B. mic*
isolates. The chemical proces
that make life possible are cataly
by proteins called enzymes, wit
specific enzyme responsible fo
specific step in the cell's chemis
Since the basic chemistry of all
is remarkably similar, the sa
enzyme (isoenzyme) performs
same task (such as breaking do
sugar for energy) in animals rang
from amoebas to zebras. But w
they do the same thing, the
enzymes of different species h
different physical properties,
these differences can be visuali
by the pattern the enzymes m
when migrating in an electri
starch gel. The changes may
subtle but the investigative met
is so sensitive it can detect mutat
leading to incipient speciation.

Researchers applied this pow
ful probe, gel electrophoresis,
comparing isoenzymes extrac
from "Nantucket human" *B.*
croti and from strains isolated fr
wild rodents inhabiting Nantuc
and England. No differences w
found.

While the parasite species
now been definitely identified as
microti, the question remained
to its origins. Which species of
dents acted as reservoir hosts
how prevalent was the infect
among them? Using peanut bu
as bait, the researchers trap
mice, voles, and rats. They
covered that only deer mice (*Pe*
myscus leucopus) and voles (*Mic*
tus pennsylvanicus) were infect

Now the *Babesia* species and
reservoir hosts were known,

searchers still had not identified e transmitting tick. The trapped les and deer mice carried both val and nymphal stages of two k species. One was *Dermacen-* *variabilis*, whose adults feed inly on dogs; the other was a ecies resembling *Ixodes scapu-* *is*, whose adults prefer deer. The ung of these species are not ex- isive to rodents and will bite mans who brush by the vegeta- n on which they rest. While all evidence is not in, the species sembling *I. scapularis* appears ely to be the vector.

The development of *I. scapu-* *is* coincides neatly with the tour- season. In early summer the mphal ticks, already infected th their charge of *Babesia*, await ir next hosts, primarily rodents, hough humans will do. Most of e human babesiosis cases on ntucket have occurred in late mmer and early fall. The infec- ns that occurred in the summer re presumably transmitted by bites of nymphal *Ixodes* ticks. ring the fall, the ticks feed on blood of deer and then, as the ather turns colder, drop off to erwinter on the ground.

Finally, the investigators wanted know the full extent of human besiosis on Nantucket. Were the gnosed cases only the tip of the berg or did those with clinical nifestations represent the limit the infections? Analyses of the ta disclosed that all those with mptoms severe enough to seek dical help were older people, nging in age from 52 to 85 years. ost of them were also economi- lly well off. Generally, the more urious homes on Nantucket are ated some distance from the nd dunes and beaches, in an area t, ecologically, is cheek by jowl th the scrub, the natural habitat tick and deer.

Again, the laboratory served epi- miology. Infection, even when nically inapparent, will elicit anti- dy that may persist for some ars. The detection of these anti- dies can provide a highly useful ltale as to who has or has had the ection. A full-scale "bleed" of ntucket's permanent and sum- r population has not yet been rried out, but the results of the t "grab bag" sample suggest a h risk of infection. Approxi- tely 2 percent of the people whose blood was tested showed antibody against *B. microti*, yet the great majority of these people could not recall having any of the malaria-like symptoms of the clinically afflicted. At the relatively nonpathogenic end of the infection, however, the symptoms may be so ephemeral as to go unnoticed.

While members of all age groups have apparently been infected, clinical babesiosis seems to be a senior citizen's disease. This agrees with the topsy-turvy immunological pattern that animal babesiosis has shown. Young domestic animals are highly tolerant of *Babesia* infections, while older animals are particularly susceptible. Ranchers have exploited this age-specific resistance by purposely infecting young stock, which ultimately produces an immunity that protects them in later life. If older animals without antibody were moved into tick-infested range, they would rapidly sicken with babesiosis and the mortality would be high.

We can only speculate upon the historical dynamics that led to the present situation on Nantucket. Retrospective epidemiology is a difficult and sometimes dangerous exercise. And the problem of reconstructing the epidemiological events associated with Nantucket babesiosis is even more thorny because there is no precedent or parallel experience to guide the deductive process.

The visitor to Nantucket gains an impression of unspoiled, unchanged permanence reaching to a distant past. The carefully nurtured and protected island is indeed a delight, but major changes in its landscape have occurred even within living memory.

Prior to colonial settlement, Nantucket was probably forested. Indians hunted deer here with the aid of selective burning, which seemed to cause little permanent ecological disturbance. During the mid-seventeenth century, British commercial enterprise began with the collecting of sassafras, which at the time was selling very nicely on the London market as an aphrodisiac. These early porn brokers were succeeded by a more somber lot of farmers who made the island into a sort of ovine condominium, the land being held in common through a system of shares allotted to individual sheep farmers. The sheep population burgeoned and, according to historical reports, reached an estimated 10,000 to 17,000 by 1875. Sheep are highly efficient grazers and this large population not only deforested the island but also reduced it to close-cropped pasturage. Photographs taken in the early 1900s show an island of grass unrelieved by a single tree.

Sometime during the nineteenth century the combination of dwindling forest cover and increased hunting exterminated the deer and probably the tick *I. scapularis*. The absence of higher vegetation produces a desiccating environment inimical to survival for many tick species. For many years, the Russians have recommended intensive pasturage by domestic stock as a means of controlling ticks and tick-borne diseases.

In the mid-1850s Nantucket's ecology again began to change as the island's economy slumped with the decline of both its whaling and sheep industries. The common land system had already come under attack by wealthy proprietors who in 1812 petitioned the Supreme Court to cede them large acreages. Later, cranberry farmers—and then the wealthy in search of summer retreats—progressively reduced the amount of land grazed by sheep. With their disappearance, the island underwent a botanical transformation. Wes Tiffney, head of the University of Massachusetts field station on Nantucket, believes that the proliferation of indigenous bayberry facilitated the changes that took place in the former sheep pastures. He and his colleagues have shown that, like legumes, bayberry fixes nitrogen and thus enriches the soil. As a result, since 1890 most of inland Nantucket has grown up in heath and scrubland, ideal habitat for ticks. In 1830, settlers introduced pine trees to serve as windbreaks and their spread into discrete forest stands provided the sanctuary necessary for the deer's comeback.

The first deer to return came by sea. In 1922, a Nantucket fisherman rescued an exhausted buck as it swam from the mainland. Four years later, two does were imported from Michigan, and additional deer were brought in during the 1930s. This meager nucleus has now pro-

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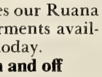

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duced a herd estimated at between 500 and 1,000 animals.

At some point when deer were being imported, the *I. scapularis*-like tick covertly came with them. It, too, flourished and has now become the dominant tick species on the island. The reason for its proliferation is somewhat of a mystery. During entomological surveys of Nantucket in 1937, 1941, and 1944 no *I. scapularis* were found. However, *I. muris*, a tick species exclusive to rodents, was abundant on these animals. This species probably cycled *B. microti* from rodent to rodent. By 1976 a striking change in the nature of the tick population had taken place. *I. muris* had virtually disappeared and the *I. scapularis*-like tick predominated.

At this point, conjecture must embellish the facts. What brought about the change in tick population? Was this change crucial for the transmission of *B. microti* to humans? The displacement of a native species by an introduced species has occurred many times in many ecosystems. Perhaps this occurred when the *I. scapularis*-like tick came to Nantucket. After all, there are just so many field mice to go around and *I. scapularis* may have consistently come to dinner before *I. muris*. Then, too, the deer host of adult *I. scapularis* is so much larger than the rodent host of the *I. muris* adult that it would be reasonable to assume that deer could support a much larger number of ticks. More adult *I. scapularis* ticks would produce more eggs and, in turn, more larvae, which could outcompete *I. muris* for hosts.

If we make the broad assumption that human babesiosis did not occur in Nantucket prior to the establishment of a sizable *I. scapularis* population, then why did only this species and not *I. muris* transmit the infection to man? Perhaps *I. scapularis* is more catholic and aggressive in its taste. The sheer density of *I. scapularis* may have also been an important factor. Another possibility is that this species occupied an ecological niche that brought it into closer contact with humans than did *I. muris*. Or perhaps *I. scapularis* is a more efficient biological host of *B. microti* than is *I. muris*. Or it may be a combination of some or all of these
factors. Perhaps the true story w
never be completely known
though the testing of these hypot
eses in order to predict, preve
or control babesiosis outbreaks
Nantucket and elsewhere would
important.

Nantucket should not be p
tured as an island embattled
babesiosis. The number of clinic
cases have, so far, been mode
and nonfatal. Nevertheless,
risk is there and those who lack
spleen or are otherwise immun
logically unresponsive should exe
cise caution if they visit the islan
There is no drug to provide an ea
cure. The antimalarials are ineffe
tive, and the treatment given catt
is too toxic for man except in situ
tions of dire emergency. Nor
there a simple solution that wou
interrupt the chain of transmissio
other than reducing or eliminati
the deer population. We do n
even know the limits of the infe
tion. Isolated cases have occurr
outside Nantucket, on Martha
Vineyard, Shelter Island, and Mo
tauk, Long Island, but all the e
dence now suggests that the con
tions inherent on a tight little isla
are responsible for the continuati
of the disease in humans.

Human babesiosis on Nantuck
represents yet another assault
our sense of complacency. T
truly great accomplishment
medical science during the la
century has been the discovery
effective means to combat the i
fectious diseases caused by ba
teria, viruses, and parasites. Wh
vaccines, antibiotics, and the flu
toilet have admirably protected
from many pathogens, the last w
has not yet been fought. Old di
eases such as influenza and m
laria are flourishing and new on
such as Lassa fever, legionnaire
disease, and human babesiosis a
always a threat. If we accept t
necessity of a strong military po
ture in times of peace, it see
just as reasonable to train a
maintain an army of medical e
perts against these new pathoge
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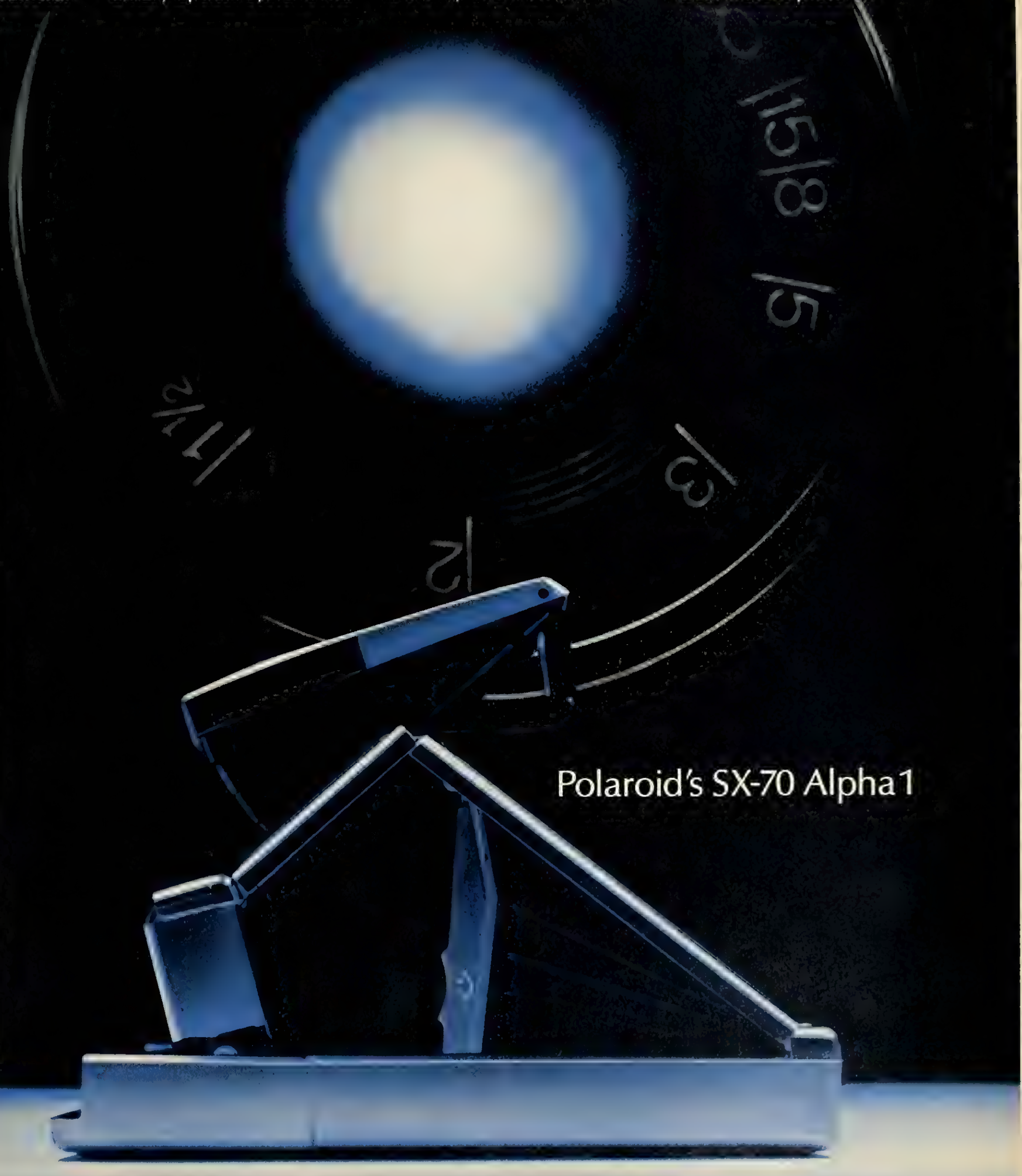

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by Stephen Jay Go

Caring Groups and Selfish Genes

Recent attacks have failed to downgrade the role of individuals in evolution

The world of objects can be arranged as a hierarchy, box within box. Molecules are made of atoms, crystals are made of molecules, and so on, to minerals, to rocks, the earth, the solar system, the galaxy made of stars, and the universe of galaxies. Different forces work at different levels. Rocks fall by gravity. At the atomic and molecular level, gravity is so weak that standard calculations ignore it.

Life, too, has many levels, and each has its role in the evolutionary process. Consider three major levels: genes, organisms, and species. Genes are blueprints for organisms; organisms are the building blocks of species. Evolution requires variation, for natural selection cannot operate without alternatives to choose among. Mutation is the ultimate source of variation, and genes are the unit of variation. Individual organisms are the units of selection. But individuals do not evolve—they can only grow, reproduce, and die. Evolutionary change occurs in groups of interacting organisms; species are the unit of evolution. In short, as philosopher David Hull writes, genes mutate, individuals are selected, and species evolve. Or so the orthodox, Darwinian view proclaims.

The identification of individuals as the unit of selection is a central theme in Darwin's thought. This idea underlies his most radical claim: that evolution is purposeless and without inherent direction. As I argued in my column for April 1977, Darwin's theory transfers to biology the individualism of Adam Smith's laissez faire economics. Smith had argued that a well-regulated economy, apparently harmonious and stable, would arise as a natural result of untrammeled self-interest, actively pursued by all. Many would lose and fall by the wayside, while winners would check and balance each other. Darwin contended that the exquisite balance of nature had no "higher" cause. Evolution does not recognize the "good of the ecosystem" or even the "good of the species." Any harmony or stability is only an indirect result of individuals relentlessly pursuing their own self-interest—in modern parlance, getting more of their genes into future generations by greater reproductive success. Individuals are the unit of selection; the "struggle for existence" is a matter among individuals.

In the last fifteen years, however, challenges to Darwin's focus on individuals have sparked some lively debates among evolutionists. These challenges have come from above and below. From above, Scottish biologist V.C. Wynne-Edwards raised orthodox hackles fifteen years ago by arguing that groups, not individuals, are units of selection, at least for the evolution of social behavior. From below, English biologist Richard Dawkins has recently raised my hackles with his claim that genes themselves are units of selection, and individuals merely their temporary receptacles.

Wynne-Edwards presented his defense of "group selection" in a long book entitled *Animal Disp*
sion in Relation to Social Behav
(New York: Hafner, 1962). He
gan with a dilemma: Why, if in
viduals only struggle to maxim
their reproductive success, do
many species seem to maint
their populations at a fairly c
stant level, well matched to
resources available? The traditio
Darwinian answer invoked exter
constraints of food, climate, a
predation: only so many can be f
so the rest starve (or freeze
get eaten), and numbers sta
lize. Wynne-Edwards, on the ot
hand, argued that animals regul
their own populations by gaug
the restrictions of their envir
ment and regulating their own
production accordingly. He rec
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contravened Darwin's insiste
on "individual selection" for
required that many individuals li
or forgo their own reproduction
the good of their group.

Wynne-Edwards postulated t
a species is divided into many m
or-less discrete groups. So
groups never evolved a way to re
late their reproduction. Wit
these groups, individual selecti
reigned supreme. In good yea
populations rose and the grou
flourished; in bad years, the gro
could not regulate itself and fa
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Other groups developed systems
regulation in which many in
viduals sacrificed their reprod
tion for the group's benefit
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encourage individuals to seek th
own advantage). These groups s
vived the good and the bad. Evo
tion is a struggle among groups,

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86 PROOF

individuals. And groups survive if they regulate their populations by the altruistic acts of individuals. "It is necessary," Wynne-Edwards wrote, "to postulate that social organizations are capable of progressive evolution and perfection as entities in their own right."

Wynne-Edwards reinterpreted most animal behavior in this light. The environment, if you will, prints only so many tickets for reproduction. Animals then compete for tickets through elaborate systems of conventionalized rivalry. In territorial species, each parcel of land has a ticket and animals (usually males) posture for the parcels. Losers accept gracefully and retreat to peripheral celibacy for the good of all. (Wynne-Edwards, of course, does not impute conscious intent to winners and losers. He imagines that some unconscious hormonal mechanism underlies the good grace of losers.)

In species with dominance hierarchies, tickets are allotted to the appropriate number of places, and animals compete for rank. Competition is by bluff and posture, for animals must not destroy each other by fighting like gladiators. They are, after all, only competing for tickets to benefit the group. The contest is more of a lottery than a test of skills; an allotment of the right number of tickets is far more important than who wins. "The conventionalization of rivalry and the foundation of society are one and the same thing," Wynne-Edwards proclaimed.

But how do animals know the number of tickets? Clearly, they cannot, unless they can census their own populations. In his most striking hypothesis, Wynne-Edwards suggested that flocking, swarming, communal singing, and chorusing evolved through group selection as an effective device for censusing. He included "the singing of birds, the trilling of katydids, crickets and frogs, the underwater sounds of fish, and the flashing of fireflies."

Darwinians came down hard on Wynne-Edwards in the decade following his book. They pursued two strategies. First, they accepted most of Wynne-Edwards's observations, but reinterpreted them as examples of individual selection. They argued, for example, that *who* wins is what dominance hierarchies and territoriality are all about. If the sex ratio between males and females is near 50:50 and if successful males monopolize several females, then not all males can breed. Everyone competes for the Darwinian prize of passing more genes along. The losers don't walk away with grace, content that their sacrifices increase the common good. They have simply been beaten; with luck, they will win on their next try. The result may be a well-regulated population, but the mechanism is individual struggle. Adam Smith's invisible hand operates again—order and harmony from the pursuit of personal gain alone.

Virtually all Wynne-Edwards's examples of apparent altruism can be rephrased just as well as tales of individual selfishness. In many flocks of birds, for example, the first individual that spots a predator utters a warning cry. The flock scatters but, according to group selectionists, the crier has saved his flockmates by calling attention to himself—self-destruction (or at least danger) for the good of the flock. Groups with altruist criers prevailed in evolution over all-selfish, silent groups, despite the danger to individual altruists. But the debates have brought forth at least a dozen alternatives that interpret crying as beneficial for the crier. The cry may put the flock in random motion, thus befuddling the predator and making it less likely that he will catch anyone, including the crier. Or the crier may wish to retreat to safety but dares not break rank to do it alone, lest the predator detect an individual out of step. So he cries to bring the flock along with him. As the crier, he may be disadvantaged relative to flockmates (or he may not, as the first to safety), but he may still be better off than if he had kept silent and allowed the predator to take someone (perhaps himself) at random.

The second strategy against Wynne-Edwards reinterprets apparent acts of disinterested altruism as selfish devices to propagate genes through surviving kin—the theory of kin selection (discussed twice in this column, May and November 1976). Siblings, on average, share half their genes. If you die to save three sibs, you pass on 150 percent of yourself through their reproduction. Again, you have acted for your own evolutionary benefit, if not for your corpo continuity. Kin selection is a f of Darwinian individual selecti

These alternatives do not prove group selection, for th merely retell its stories in the m conventional Darwinian mode individual selection. The dust yet to settle on this contenti issue but a consensus (perhaps correct) seems to be emergi Most evolutionists would n admit that group selection occur in certain special situati (species made of many very crete, socially cohesive groups direct competition with ea other). But they regard such sit tions as uncommon if only beca discrete groups are often groups, leading to a preference kin selection as an explanation altruism within the group.

Yet, just as individual select emerged relatively unscarred af its battle from above with gro selection, some other evolutioni launched an attack from bel Genes, they argue, not individu are the units of selection. Th begin by recasting Butler's fam aphorism that a hen is merely egg's way of making another e An animal, they argue, is o DNA's way of making more DN Richard Dawkins has put the c most forcefully in his recent bo *The Selfish Gene* (New York: ford University Press, 1976). body," he writes, "is the gen way of preserving the genes altered."

For Dawkins, evolution is battle among genes, each seek to make more copies of its Bodies are merely the places wh genes aggregate for a time. Bo are temporary receptacles, surv machines manipulated by ge and tossed away on the geol scrapheap once genes have re cated and slaked their insati thirst for more copies of themsel in bodies of the next generati He writes:

"We are survival machine robot vehicles blindly program to preserve the selfish molec known as genes. . . .

"They swarm in huge colon safe inside gigantic lumbering bots . . . they are in you and they created us, body and mi and their preservation is the mate rationale for our existenc

Dawkins explicitly abandons

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Darwinian concept of individuals as units of selection: "I shall argue that the fundamental unit of selection, and therefore of self-interest, is not the species, nor the group, nor even, strictly, the individual. It is the gene, the unit of heredity." Thus, we should not talk about kin selection and apparent altruism. Bodies are not the appropriate units. Genes merely try to recognize copies of themselves wherever they occur. They act only to preserve copies and make more of them. They couldn't care less which body happens to be their temporary home.

I begin my criticism by stating that I am not bothered by what strikes most people as the most outrageous component of these statements—the imputation of conscious action to genes. Dawkins knows as well as you and I do that genes do not plan and scheme; they do not act as witting agents of their own preservation. He is only perpetuating, albeit more colorfully than most, a metaphorical shorthand used (perhaps unwisely) by all popular writers on evolution, including myself (although sparingly, I hope). When he says that genes strive to make more copies of themselves, he means that "selection has operated to favor genes that, by chance, varied in such a way that more copies survived in subsequent generations." The second is quite a mouthful; the first is direct and acceptable as metaphor although literally inaccurate.

Still, I find a fatal flaw in Dawkins's attack from below. No matter how much power Dawkins wishes to assign to genes, there is one thing that he cannot give them—direct visibility to natural selection. Selection simply cannot see genes and pick among them directly. It must use bodies as an intermediary. A gene is a bit of DNA hidden within a cell. Selection views bodies. It favors some bodies because they are stronger, better insulated, earlier in their sexual maturation, fiercer in combat, or more beautiful to behold.

If, in favoring a stronger body, selection acted directly upon a gene for strength, then Dawkins might be vindicated. If bodies were unambiguous maps of their genes, then battling bits of DNA would display their colors externally and selection might act upon them directly. But bodies are no such thing.

There is no gene "for" such unambiguous bits of morphology as your left kneecap or your fingernail. Bodies cannot be atomized into parts, each constructed by an individual gene. Hundreds of genes contribute to the building of most body parts and their action is channeled through a kaleidoscopic series of environmental influences: embryonic and postnatal, internal and external. So parts are not translated genes, and selection doesn't even work directly on parts. It accepts or rejects entire organisms because suites of parts, interacting in complex ways, confer advantages. The image of individual genes, plotting the course of their own survival, bears little relationship to developmental genetics as we understand it. Dawkins will need another metaphor: genes caucusing, forming alliances, showing deference for a chance to join a pact, gauging probable environments. But when you amalgamate so many genes and tie them together in hierarchical chains of action mediated by environments, we call the resultant object a body.

Moreover, Dawkins's vision requires that genes have an influence upon bodies. Selection cannot see them unless they translate to bits of morphology, physiology, or behavior that make a difference to the success of an organism. Not only do we need a one-to-one mapping between gene and body (criticized in the last paragraph), we also need a one-to-one *adaptive* mapping. Ironically, Dawkins's theory comes just at a time when more and more evolutionists are rejecting the panselectionist claim that all bits of the body are fashioned in the crucible of natural selection. It may be that many, if not most, genes work equally well (or at least well enough) in all their variants and that selection does not choose among them (see my column of December 1975 on the theory of neutrality). If most genes do not present themselves for review, then they cannot be the unit of selection.

I think, in short, that the fascination generated by Dawkins's theory arises from some bad habits of Western scientific thought—from attitudes (pardon the jargon) that we call atomism, reductionism, and determinism. The idea that wholes should be understood by decomp
sition into "basic" units; that pro
erties of microscopic units c
generate and explain the behavi
of macroscopic results; that
events and objects have definit
predictable, determined cause
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truth.

Biologist Stephen Jay Goul
most recent book is Ever Si
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The Problem With Simple Folk

by Peter J. Wilson

Some peoples, like the Tsimihety of Madagascar, prove difficult to describe because they don't take structure as seriously as anthropologists do

In the Indian Ocean, 250 miles off the southeast coast of Africa, lies Madagascar, called the Great Red Island because it is a thousand miles long and composed of red laterite soil. It contrasts steamy, tropical rain forest on its east coast with cool, temperate highlands in its center and arid deserts in the south and west. Its five million people came across the Indian Ocean from the islands of Indonesia. But they have African blood, particularly those who live on the west coast where Arab traders landed with African slaves.

Runaway slaves from East Africa settled in Madagascar, and the political structure of many Malagasy is clearly African. People look more European on Madagascar's northeast coast, where in the seventeenth and eighteenth centuries Malagasy mated with European pirates. The Malagasy language bears out the people's Indonesian origins, for it is distinctly Malayo-Polynesian and seems most closely related to Maanjan, a language of Borneo.

Some years ago I spent a year among the Tsimihety people of Madagascar, who live in the north-central interior's hilly savanna, which is separated from the highland plateau by a belt of forest. The Tsimihety live in villages of 20 to 500 inhabitants; their huts are made of mud and cattle dung. Herding cattle and growing rice are the principal Tsimihety occupations and my objective was to find out how these occupations might determine other aspects of Tsimihety life. My research should have resulted in the customary scholarly articles, climaxed by a monograph that would have entered the Tsimihety into the ethnographic annals. So far, I have written a few articles, but the awaited monograph is still stuck somewhere between my field notes and my intentions. Since my stay with the Tsimihety, several English-speaking anthropologists—for whom Madagascar is virtually terra incognita—have studied Malagasy tribes, and one, Maurice Bloch, has actually published a monograph. Whether the others suffer from my own block I cannot say, but they have not been prolific. Fortunately, French anthropologists have published a large number of studies, many of them excellent. Is it perhaps a coincidence that Bloch is a native-born Frenchman, even though he grew up and was educated in England? Do English anthropologists, who can cope very well with the anthropology of the British Empire, or Americans, who can handle the Spanish Empire, find the combination of the erratic French and the indigenous tribes who have come under their aegis in Madagascar just too much for Anglo-Saxon susceptibilities?

I think there may be something in this, but as for me, I think my difficulty originates with the Tsimihety themselves. In any case, after seventy years of French colonial rule, they remain impervious to French culture. As I have tried, time and time again, to report on the Tsimihety to the anthropological fraternity, I have begun to wonder whether my specific problem is not far more general than is at present realized or admitted. Perhaps many more of the world's tribes than we suspect do not lend themselves to being described systematically by anthropologists.

Since Sir James Frazer, in *The Golden Bough,* more or less defined anthropology for the layman, civilization's interest in non-European cultures has been guided by curiosity about the strange and exotic aspects of our own beg nings. Contemporary anthropo gists, like their nineteenth-centu colleagues, see the exotic as ch lenging them to make some se of it by ferreting out the logic a rationality that presumably lies hind alien behavior. And so library is stocked with descriptic and analyses of tribes who, in th own way, are shown to be as int lectual as the anthropologists w study them—tribes whose lives volve around dominant them rationalized, highly structured stitutions; metaphysical me phors; and central ideas.

But what of those tribes, such the Tsimihety of Madagascar, w do not appear to be of a me physical bent; who show little c cern about conforming to a u fied, coherent philosophy or so system; who live opportunistica unspectacularly, with as little f and bother as possible; who app to an outsider to be pragma utilitarian, mundane, and with the constraints or esthetics o systematic, ordering structure?

The Tsimihety cannot be in preted in the light of environme determinism for they are a pec who choose where and how t will live, selecting their own vironmental conditions. Tsimih move in search of new cattle p tures, but they lack the comp tive pride in cattle ownership would transform it into an e nomic institution. Similarly, m Tsimihety villages grow rice, production and exchange vary i syncratically from village to lage.

These are hardly the sort tribes who can provide the ant pologist with a new model tc slotted into the anthropolog repertoire or help him dazzle colleagues with a virtuoso anal of a new logic. The people of s tribes don't do things, don't t new thoughts, don't create symbols; they can, in a sense, described negatively, by com- ring them with neighbors who do lieve in reciprocity or do prac- e elaborate rituals crammed with ysterious symbols; who do tell ntrapuntal myths or prescribe eir daily lives through kinship. t there is not much point in try- to write 200 pages or so listing the things a tribe doesn't do.

Yet, the Tsimihety do not live in aos or anarchy and their lives d tribe are not disintegrating. e first census of the Tsimihety, en about 1900, placed the popu- ion at 60,000, a figure that can- t be taken too seriously, given tribe's lack of sympathy for ch an enterprise. But the most ent census numbers the Tsimi- ty at more than 400,000, firmly ablishing that they have multi- ed enormously.

Once I had explained my pur- se in being among them, the imihety were more than friendly d went out of their way to keep informed. In fact, most Tsimi- y were natural ethnographers, erting that they lived the best of possible lives in the best of all ssible ways. They never tired of nting out how different—and in- ior—were the customs of neigh- ing peoples. Actually, the dif- ences were only minor. Mada- car's twenty tribes share many tural elements, based on a com- n language and a common an- tor and funerary cult, which is, h Christianity, the recognized gion of the Malagasy Republic. themes of Tsimihety culture are sent throughout Madagascar, where other tribes orchestrate se themes in different styles, Tsimihety simplify them down the bare essentials.

oon after my arrival in the trict town of Mandritsara, the mihety heartland, the "mayor" led together as many elders as could contact, and for three 's we sat in his office and rked out a list of Tsimihety

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Pest Protection

Cultivation in the early spring also helps us control insects and pests by destroying their breeding places, both above the soil and just beneath its surface.

In the Gallo vineyards, we might point out, we probably do more cultivating than normal simply because we prefer not to use herbicides when we can avoid them.

That same policy applies to the use of insecticides. We prefer natural controls.

For example, in one of our vineyards, instead of spraying to eliminate the destructive leaf hopper, we planted a number of wild blackberry bushes nearby to provide a refuge for several colonies of wasps.

The wasps then laid their eggs within the eggs of the leaf hoppers and thus prevented them from hatching.

In another case, rather than spray with an herbicide to control an obnoxious weed called puncture vines, we used weevils.

These natural enemies then burrowed into the germ of the puncture vine seeds and prevented them from sprouting.

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We also rely on cultivation to enhance the effectiveness of our fertilization programs.

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Then, too, during vineyard operations, soil often becomes compacted, a condition that could destroy the vine's fine root system.

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clans—their genealogies, histories, and domains. The townspeople not only thought that this was an obvious thing to do, but expressed astonishment at their not having done it before. As for kinship and descent, the social anthropologist's bread and butter, there was no reticence about explaining how they worked and what their role was. But no orderly kinship system provided the Tsimihety mind with a blueprint for actions and social relations. Tsimihety kinship terminology is a fairly common variant of the Iroquois system. Descent through males is commonly practiced, but in no case as an orthodox principle. Sometimes it is not recognized at all. One of my most memorable evenings was spent in a hut trying to convince the resident family and its neighbors that matrilineal descent existed and that many African tribes lived by its rules. My listeners were fascinated but incredulous, pointing out immediately the inherent problems of this system, and firmly avowing that people who followed it must be simple or stupid or both. Yet the Tsimihety are by no means averse to recounting genealogies in which descent is regularly traced through the mother's brother or where residence after marriage might be in the bride's village. For them this is no contradiction. Expediency and freedom from structural purity come first.

Therein lay the catch for me: there did not seem to be a Tsimihety way of going about things, at least not a way so well defined that it could constitute a sort of ethnographic trademark. What these people did and thought was simple and straightforward, devoid of flourish and subtlety, and suited to personal situations. Some villagers irrigated their rice fields while others relied upon rain. Some organized cooperatives that exchanged labor; others worked on their own. Some men performed a certain ritual using a prayer; others omitted the prayer or used a different one. I see the Tsimihety as a people wholeheartedly dedicated to the possibilities of freedom, probably more so than any other people I have read about. While sharing with all Malagasy a common culture, they have, within its limits, refused to be imprisoned by the demands of system and symbol.

For all Malagasy, ancestors are the most important aspect of life. Every person looks forward to becoming an ancestor, a status insured by the birth of children and then grandchildren. The ancestors keep a constant watch on all that goes on and are quick to react when they are not given their due—sacrificial offerings, observance of taboos, and the building and upkeep of tombs.

In return, the Tsimihety expect protection against illness, misfortune, bad crops, and supernatural forces. Sacrifices to ancestors are not particularly inconvenient; they usually consist of small offerings of honey placed in a raffia tube hung in the house, a libation of rice water, coffee, or fermented cane juice poured on the floor, or a mention in a prayer prefatory to an undertaking. But the Tsimihety make these offerings only if and when they think of doing so—and then in a thoroughly offhand manner. Only when something goes drastically wrong—when crops fail, when cattle are missing, or when people fall ill—do the Tsimihety seem to take spirits and ancestors seriously. Then individuals will consult a medicine man-diviner (*ombiasa*) to pinpoint the cause of the trouble, meanwhile urging the *ombiasa* to prescribe the cheapest possible sacrifice. If only an ox will do, they will make sure that the oldest, feeblest beast in the herd is sacrificed.

Observance of taboos (*fady*), usually by promising to avoid acts or objects favored by particular ancestors, is equally lackadaisical. In return, the Tsimihety request similar abstinence from the ancestors. In very few cases can these taboos be considered onerous. Common taboos are small birds or insects that no one would eat anyway or oxen without horns. Taboo days, when work is forbidden, are more significant because of the frustration they used to cause the French colonial administration and now cause the present government. Although these taboos play a large and important part in the regulation of Tsimihety life, a broken taboo, even the rare instance of incestuous marriage, is no great calamity. Taboos are certainly not allowed to interfere with practical matters. One village had inherited taboos on eating or using sug
cane and on traveling at a certa
time. Since these were inconve
ient, the villagers arranged that t
oldest woman among them wou
observe the taboos on everyone
behalf.

Tsimihety tombs are perhaps t
best illustration of the people
matter-of-fact approach to li
While other tribes of the isla
build elaborate tombs, highly de
orated and very visible, the Tsin
hety place their dead in natu
caves hidden high in the hills.
fact, they indulge in no artistic pu
suits whatsoever. The raffia cl
they weave has no design and
left its natural color; their tools
plain and finished only enough
make them usable. Their mus
rarely performed, is crude and e
mentary compared to the skill
instrumentation and singing
other tribes. A Merina *valiha*,
zitherlike instrument easily fou
in the marketplace, is highly d
orated, but a Tsimihety *valiha*
rare object, is a plain raffia pa
tube with wooden strings. (T
Merina are the largest ethnic gr
on Madagascar.) The Tsimih
drum, once made of wood
cowhide, is now usually an ena
bowl covered with cloth. Tsimih
cuisine consists of boiled rice
companied by a boiled vegeta
or, if a special visitor arrives, b
boiled chicken. Meat is eaten o
when an ox must be sacrific
The standard drink is rice wa
made by allowing rice to for
burned crust around a pot's e
the crust imparts a flavor to
water.

One possible explanation for
unadorned culture is that it i
decline. Has exposure to E
pean culture brought so m
change that I observed only r
nants of a more sumptuous
authentic past? Yes, there
instances, such as that of the dr
where modern items have
placed some indigenous ones.
generally speaking, the Tsimi
are dyed-in-the-wool cultural
servatives. In the mid-1820s, w
Radama I, the Merina king
conquered most of Madagasca
vaded Tsimihety, the people's
action was to retreat to caves i
hills, offering no resistance, lea
villages either abandoned or
one or two elderly people
ing the fort. In order to mai

'I had just about decided that hotography and I weren't meant r each other. My pictures were ull and amateurish, but I figured at a really good 35mm camera ould be both too complicated d expensive for me.

"Boy, was I wrong! Luckily, efore I gave up, I talked to a iend who knows about cameras. e put his Nikkormat FT3 into y hands. Told me how it was ade by the Nikon people, who ake the sophisticated cameras ost professional photographers e. He showed me how easy it as to use . . . took me just inutes to get the hang of it. hen he mentioned how little it st, my mind was made up. The xt day, I went out and bought y own Nikkormat FT3.

"Things haven't been the me since. My very first roll of m had the sharp, clear photos d always hoped for–just about ery shot was perfect. And, once tarted using the camera more ten, I found out what that Nikon ality and reliability did for me.

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his rule, Radama brought Merin
to settle in Tsimihety territory. Th
Tsimihety countered by placing
total taboo on all interaction wit
the Merina. (Because the Merin
were Christians, this taboo in
cluded Christianity. European mi
sionaries have since had a mo
unrewarding time trying to conve
the Tsimihety.) When the Frenc
took over Madagascar in the 1890
the Tsimihety again resisted pa
sively. In reports to the governo
French-appointed district office
uniformly complained of the in
possibility of getting cooperatio
work, or taxes out of the Tsim
hety. Neither threats nor persu
sion ever worked. The French di
tributed plows to each village, ho
ing that Tsimihety rice farmi
would become more efficient a
productive. Today the Frenc
plows stand half-buried in front
village houses, and the Tsimihet
as they have always done, prepa
rice fields by allowing cattle
trample them.

The colonial government consi
ered education a necessary instr
ment of development, and in mo
of Madagascar, particularly in t
highlands, literacy is highly valu
and almost universal. The Tsin
hety, however, have generally
fused to allow schools to be bu
in their villages. If the governme
offered a grant, the village wo
accept the money with profu
gratitude and promises—but u
ally would somehow never find t
labor to build a school. If the Ca
olic Church, the London Missic
ary Society, or another priv
organization built a school,
Tsimihety rarely sent their childr
there. Such schools were attend
by Europeans or by children of i
migrant tribes.

Yet I cannot get away entir
with this generalization, for
Tsimihety are individualists. So
villages and some individuals h
gone out of their way to acquir
modern education and to gain
try into a new world. From a tr
that has deliberately chosen to p
serve its preliteracy and its o
ways, came one of the pri
movers for Madagascar's in
pendence, the first French col
to achieve this status after W
War II. Philibert Tsiranana,
Tsimihety village schoolmaster
came the first president of
Malagasy Republic and his c

was dominated by Tsimihety.
hat the first president of the
ublic should have been a Tsimi-
y masks another irony. Al-
ugh other Malagasy tribes have
ous forms of political and social
archy, the fiercely egalitarian
nihety recognize no office to
ch they assign responsibility or
obedience. Every village is a
untary confederacy of house-
ls; each has an equal say in
l affairs, exercised through the
versal Malagasy institution of
fokon'olona (village assembly),
ch is presided over by the vil-
elders. No two villages are in
tical alliance, although some
re cultivation and living space
pasture. Apart from the right
ndividuals to be buried in family
bs, no person or household
s allegiance to, or has any
n on, the village. All are free to
e at any time. Equally, indi-
uals who disturb the village
asked to leave. Especially in
dry season, numerous families,
r belongings piled on ox carts,
off for other villages or to
estead on their own. They give
ariety of reasons for moving.
most common is a desire for
scenery, but some families
new cattle pastures or better
fields or new neighbors. Such
dom of movement is hardly
lucive to hierarchy.

f course, the French and the
agasy government after them
tried to govern the Tsimihety.
ricts are supervised by a dis-
officer; within the district
quartiers, with appointed and
ied officials, and villages, each
a *chef de village*. The Tsimi-
have little choice but to ac-
these formalities. At the same
they have found ways to avoid
structure for all practical pur-
s and thereby preserve their
ocracy. An instruction from
district officer goes down the
rchy to the *chef de village*,
conveys the order to the
le. Once, the *chef* of the
ge where I lived called together
fokon'olona and appeared
sed in a huge military great-
, from which only his bare
and his bare feet protruded.
riously imitating the district
er, he announced the amount
collection date of the village's
s. The people discussed the
er and then the senior elder

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stood up and, imitating Presiden Tsiranana, directed the *chef* t report back that since the administration had done little for th villagers in the past year, they saw no reason to pay for services no rendered.

Generally, the Tsimihety refus to acknowledge hierarchy an authority vested in individuals. Ye I visited two villages ruled b chiefs whose office was hereditar and sanctified by ritual. Howeve the anthropologist tries to build model describing the Tsimihety, h finds the joinings insecure. Whenever he generalizes about commo cultural norms, he has to insert caveat.

Perhaps the constraint of havin to provide a coherent and systematic account of some aspect an alien form of life has impose upon anthropologists the structur that they attribute to other people Perhaps the esthetic necessity basing a monograph upon a centra theme or problem has led anthropologists to overplay one or another of the possible models the think they can discern for anothe culture or even to give us a mod for its own sake, irrespective what they have, in fact, observe and recorded. Undeniably, man of the world's peoples have indee developed intricate, beautiful, an intellectual philosophies and co mologies by means of which the live out their lives in structur symmetry.

My own feeling, however, is th the Tsimihety, like many oth peoples, have—for one reason another—developed an unspe tacular, flexible, pragmatic, a utilitarian solution to social lif They choose to retain their fre dom, giving up the possibility producing a thoroughgoing met physic by which they might org nize their lives systematically. F them the world—often incompr hensible and always piecemeal exists as a fact and not as a close bounded system to be kno through central metaphors. piecemeal world is a free world a that contention is surely the Tsim hety philosophy.

Peter J. Wilson, professor of a thropology at the University Otago, Dunedin, New Zealand, on sabbatical leave at Church College, Cambridge, England.

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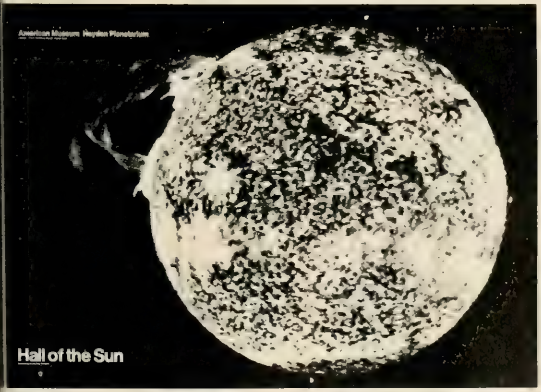

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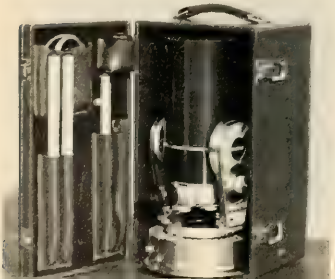

THE 1978 NATURAL HISTORY PHOTOGRAPHIC COMPETITION

This year, the Grand Prize of *Natural History*'s photographic competition will be two tickets for the American Museum of Natural History's Discovery Tour of Egypt. The three-week trip will include a two-day stop in London, followed by a leisurely cruise down the Nile from Cairo to Aswan, with an optional flight to Abu-Simbel. This will be an unsurpassed opportunity to photograph the Nile's abundant and unusual bird life, as well as the temples, tombs, and sphinxes of such remarkable sites as Memphis, Karnak, Luxor, and Thebes.

Besides the Grand Prize, the 1978 competition offers cash prizes totaling more than $3,000. The winning entries will be published in a special double issue of *Natural History* in August and will be exhibited at the American Museum of Natural History.

The four categories for entries are broad enough to fit the interests of any photographer. They are: (1) The Natural World; (2) A Sequence of an Event in Nature; (3) Photomicrography, including pictures with a scanning electron microscope; and (4) The Human Environment. First Prize in each category is $500. In addition, all entries are eligible for the following awards: Humor in Nature, $200; Urban Wildlife, $200; and ten Honorable Mentions at $100 each.

The deadline is April 15, 1978. Please put your name and address on every entry and include a stamped, self-addressed envelope—since we do want to return your pictures to you.

To all, the best of luck!

THE RULES

1. The competition is open to everyone except employees of the American Museum of Natural History and their kin.

2. Competitors may submit up to three previously unpublished entries in each of the four categories. Decision of the judges is final.

3. The Museum acquires the right to publish and exhibit the winning photographs and to use them for promotional purposes. The Museum assumes no responsibility for other entries.

4. Entries may be transparencies or prints up to 8 by 10 inches, and each must bear the photographer's name and address.

5. Enclose a self-addressed, stamped envelope for the return of entries.

6. Entries must be postmarked no later than April 15, 1978.

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Eucalyptus Bark

by Edward S. Ayensu

photographs by Gail Rubin

A mixture of pigments, tannin, and acids, influenced by climatic variations, produces endlessly changing designs

No one is certain how many species of eucalyptus trees exist, but there are between 400 and 500, making the *Eucalyptus* genus one of the largest in the plant kingdom. Some species are probably best known for the sweet-smelling oil their leaves produce, while the leaves of other species provide the sole forage for koalas, both the tree and the animal being indigenous to Australia. Eucalyptus species are also indigenous to Tasmania and New Zealand.

For more than one hundred years, thirty to forty species of eucalyptus have been grown on different continents, introduced when it was discovered that the wood of the fast-growing and versatile trees could be put to any number of uses. Wherever one travels in the world's warmer and more arid regions, eucalyptus trees now thrive—their great height and drooping, leathery leaves often contrasting sharply with their stark surroundings. The trees are common in southern Asia, Africa, the Middle East, and in the western United States. On a global scale, more than twenty million acres of the trees are growing.

In the late nineteenth century, eucalyptus seedlings were introduced into what is now Israel (where the accompanying photos were taken), in order to aid the draining of malaria-infested coastal swamps. Today, twenty species of eucalyptus, growing on some 25,000 acres of land, serve numerous purposes: as sand dune stabilizers and windbreaks along roads, in soil conservation projects, and as a source of lumber and fuel.

Most eucalyptus plantations were begun because of the need for firewood. Now, some species are used for hardwood lumber, while the wood of others is used for transmission poles, pilings, railroad ties, pulp, plywood; as charcoal; and in the manufacture of fiberboard and chipboard. The tannin of some species is extracted for leather processing and the abundant supplies of oil in the leaves are used in medicines, perfumes, and solvents.

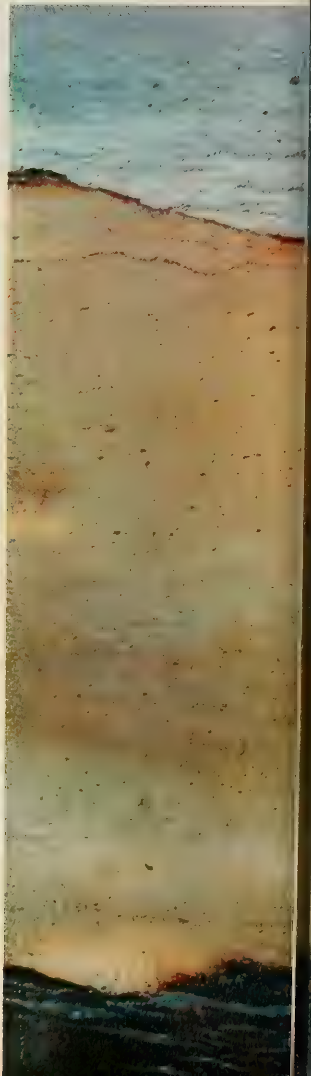
Eucalyptus trees make up three-quarters of the entire tree population of Australia. Prior to commercialization on a massive scale, Australian aborigines used eucalyptus bark for canoes, roofing, ropes, shoes, stools, and sacks.

In most places throughout the world, the varieties of eucalyptus still retain the common names they were given in Australia long ago. Many of these refer to the unique and sometimes flamboyant characteristics of the bark, the trees' most identifiable trait. Stringybarks, for example, have thick, long-fibered bark that peels off in strips. Ironbarks produce rough and deeply furrowed hard bark whose extremely short fibers break up into small polyhedrons with a texture like that of hard cork. Other species are called "boxes" because of their thin, scaly, square-shaped bark pattern.

Whether the bark is hard, scaly, long- or short-fibered, it takes on marvelous patterns and hues that rival the imagination of the most skillful modern artist. The art form unfolds when the trunk's diamete grows to such an extent that th bark tissues stretch and subse quently crack to form various pat terns.

The composition of bark is mo complex than meets the eye. Tre contain two thin, but distinc layers of tissue—the vascul (wood) cambium and the cork ca bium—which encircle the trunk b neath the bark. The vascular ca bium produces the inner portion the bark, or phloem. The prom nent outer bark is derived from t cork cambium, or phellogen, layer that forms as the tree grov in diameter. The phellogen pr duces to its outside a corky tiss known as phellem, or ordina cork, and to its inside a minor lay of tissue known as phelloderm. T two types of tissue—cork cambiu and ordinary cork—are collective known as periderm. Exterior to t periderm in young trees is anoth layer of cells that make up a tree epidermis. As a tree expands girth, the cells of the epiderm divide, stretch to their limit, a burst, and the epidermis lay sloughs off. The periderm layer tissue then multiplies, replacing t epidermis and forming the out protective coating of bark. At t point, the various bark character tics of each tree species develop

The intricate color patterns eucalyptus bark result from t abundant amount of anthocyan and, to a minor degree, tann which the trees produce. Anth cyanin, formed by sugar and oth compounds, produces red, bl and purple pigments in varyi hues. The anthocyanin pigmen tion manifested in eucalyptus b is a result of a rather complicat phenomenon. Simply put, the co



bination of colors and their intensity derive from the concentration of the different pigments, the modifying effects of color rendition due to the presence of tannin, the physical state of the anthocyanins—whether they are in solution or absorbed—and the acidity of the cell sap. In acidic solution, anthocyanins are usually red, but as the acidity decreases, the color changes to blue and violet.

Color variations may also result from the reaction of tannin to metallic elements in a tree's sap. For example, the combination of ferric iron and tannin in such eucalyptus species as mountain ash, messmate, stringybark, and alpine ash causes bark patterns ranging from blue to mauve to dark red.

Although a considerable amount of research has been conducted on anthocyanin, very little is known of its actual formation other than that the process differs from one kind of plant to another. Researchers have discovered, however, that the characteristics of the pigments are closely associated with the accumulation of sugars in the plant. Any environmentally induced factor—drought, poor nitrogen supply, low temperature, or high light intensity—that favors an increase in a plant's sugar content, often results in the increase of anthocyanins.

Given the virtually infinite variations in the genetic makeup of eucalyptus trees and the different environments in which they grow, the combinations of shapes and colors of bark are also infinite. Even from day to day, the delicate designs and hues of these trees are constantly changing as the bark peels in different successions and shapes, the removal of each piece subtly altering the appearance of the trunk. □

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The Edge of Europe

y John F. West

hotographs by Michael Spring

s an ancient way of life n the Faeroe Islands ies, peace-seeking acationers are reclaiming solated villages

The Faeroe Islands are a world mist and drizzle hurled against ay-green mountains; of stony, eeless valleys, wet moorland, and ack basalt cliffs rising a sheer 500 feet above the wild, but pat- rned, swirl of the tides. Even in mmer, storms can throw one on the hospitality of strangers for ys on end; in the winter, it could for weeks.

Much of the 550 square miles of is Danish dependency, located out midway between Norway d Iceland, looks as it did when orsemen first settled it 1,100 ars ago. Even the Faeroese lan- age, like Icelandic, has changed little from the Old Norse of the Vikings.

Isolation from world population centers, pronounced until the present century, has bred an independent, hardy people, who live in a hundred or so villages and small towns that look out across the straits or nestle in the fjords of the islands. Some of the houses are still grass roofed, and until a decade or two ago, the acrid but comforting smell of peat smoke hung over the more remote villages. Some of the older men, carrying on traditional sheep raising and cod fishing, wore handmade lambskin shoes fastened around their ankles with multicolored woolen bands.

Sheep raising used to be the islanders' most important activity (*faeroe* means sheep islands). The sheep are now rounded up twice each year—in June for shearing and in October for slaughtering. After the animals have been butchered and skinned, the carcasses are hung in curious little wood-slat outhouses to dry in the winter winds, creating a tough but tasty meat that the Faeroese eat raw in thin slices. For centuries, wool played an important part in the economy and until a hundred years ago was the principal export.

The Faeroese distant-water fishery began to develop about a century ago; the first vessels used were wooden smacks that sailed to Iceland and Greenland every summer. Then, the fishermen used ordinary handlines. Just before World War II, the Faeroese bought their trawlers. During the war, smack fishermen performed heroic service running cargoes of Icelandic fish to a beleaguered Great Britain. Wartime earnings, together with some Marshall Plan financial aid, led to the establishment of a modern Faeroese fishing fleet.

Today, fishermen work aboard well-equipped trawlers, seiners, or

he intensity of traditional cupations on the Faeroes has ssened since the end of World ar II. Tórshavn harbor used to full of fishing boats, which ft each dawn and returned imming with cod each evening. ow, many of the boats are used r pleasure. Small-scale sheep ising, also once common on the ands, has dwindled as more ople either buy their wool or ve joined the labor pool to rk in service industries.

factory ships. Many fishermen own a share in one of the sturdy wooden vessels that work in the inshore waters. The Faeroese now export quick-frozen cod fillets, Greenland shrimp, and herring meal to a score of countries, the principal importers being Denmark, Britain, Spain, Portugal, Italy, and the United States.

One result of this economic boom has been the modernization of Tórshavn, the Faeroese capital. With a population of only 11,500, it possesses the facilities of a city ten times its size—three hotels, three banks, two libraries, two museums, a number of book stores, and a small university. Five newspapers are published and a radio station broadcasts during part of each day.

Village life is also changing. Those with good harbor facilities or those linked by the new road network, with its bridges, car-ferries, and tunnels, are doing well, but the more remote villages are in decline. In both, however, the inhabitants tend to be pulled one way by their cultural heritage, the other by their prosperity and the allure of modernization.

Typical of many northern latitude islands, bright colors predominate in settlements. House painting, to cover up the effects of severe winters, is commonly done during summer months. The local television station stops transmitting in these months and the time previously spent watching programs is taken up by staring out of windows at passersby.

The village of Nólsoy, three miles from Tórshavn by sea, is prospering. When I first visited the islands in 1956, I fell in love with this little settlement of 340 people, made it my home for the summer, and lived among its shepherds, fishermen, and smallholders. Some of the old tarred houses around the tiny harbor still had grass roofs. There was no electricity in the village and at night, one often had to rely for guidance on the phosphorescence produced by the oxidation of split fish and pilot whale meat strips hanging to dry near almost every back door.

In two decades, Nólsoy has changed greatly. An underwater cable now brings power from a hydroelectric plant twenty miles away. A new school stands on hill just outside the village. Bright painted houses have sprung u everywhere, and one is hard put find any of the cunning wood locks that were once used ever where. A new graveyard is pa tially hidden behind ugly concre walls. Two sturdy wooden smac lie moored in the enlarged harb In the fields, small tractors wi mowers have replaced scythes.

Yet much remains of the way of life in such villages Nólsoy. Old World courtesy is s

mmon among the people, and eir speech is pithy and concise, lolent with allusions to Faeroese ends and ballads. Some ballads ve been handed down orally for re than five centuries, and dur- times of celebration, the villag- sing them lustily, linking arms d dancing time-hallowed steps.

Nólsoy will undoubtedly con- ue to develop, retaining some of ancient customs, but also outing modern buildings and nveniences.

lykines, a far more isolated village, and one that lacks a harbor, does not have a future. Like a number of outlying villages and islands, it has only a past. The island of Mykines lies thirty miles to the west of Tórshavn, on the very edge of the archipelago. Here, the ancient Faeroese way of life continues little altered from Viking times, but now there are few left to carry it on. At the end of the last century, the population was 150. Today, there are only 50 people and most of the young have gone to Tórshavn and modern times. Last year, the village school closed as there were only three small children left on the island. Many of the neat dwellings along the single village lane stand empty, and visitors in search of peace can rent them for a pittance.

Mykines is probably the most inaccessible spot in Europe. The only way of getting there is on the mail boat, which sails four times a week from the village of Sörvágur, ten miles away. It is supposed to leave at 10:00 A.M., but whether it does depends upon the landing conditions on Mykines. Winds often exceed fifty miles an hour for days on end, but even more crucial is the wind direction. Even a light breeze from the south can make it impossible for a boat as small as a dinghy to land. The final decision as to whether the mail boat leaves Sörvágur rests with its eighty-year-old captain.

The first four miles of the journey are through a sheltered fjord, but once in the open Atlantic, the little wood boat begins to pitch and roll in the swells. The passengers have to clamber over crates, cardboard boxes, milk churns, an heaps of lumber, for literally ever thing that reaches Mykines is ca ried in this twelve-ton vessel. Aft three more miles, the boat come under the lee of the towering clif on the south of Mykines. The rise up, stratum after stratum

asalt, interspersed with grassy edges and, in one place, a thin eam of coal.

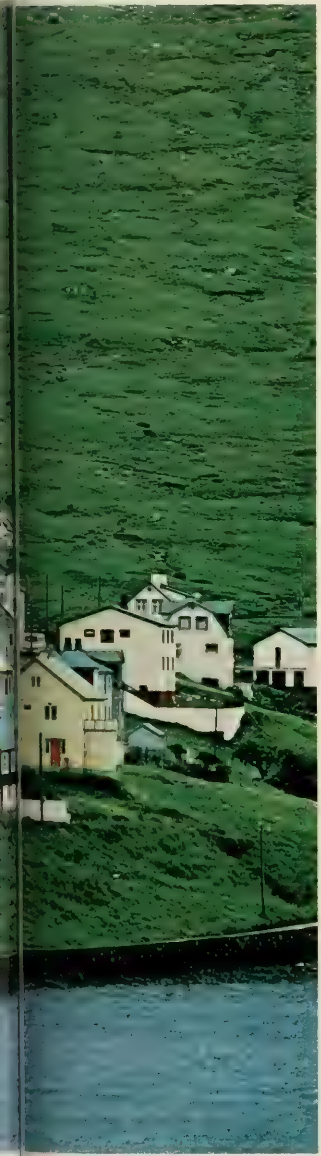
The only landing place lies at he southwest extremity of the isand. Here, a valley slopes toward he sea, terminating in a cliff a mere wenty or thirty feet high. The landing lies in a shallow basin; with an onshore wind, it alternately fills and empties with great violence. A concrete jetty juts into the basin and a stairway leads up to the tiny village. Whenever the mail boat arrives, a little crowd gathers on the jetty; invariably, it turns out to be the entire population of the island.

Nobody knows when the island was first settled. There is some evidence that by 1200, herdsmen were bringing cattle to the island to graze on its abundant summer grass. By late medieval times there was a settled population, and a tiny church had been built, as well as an even smaller chapel that was demolished during the Reformation. A Faeroese archeologist recently excavated the site and found a broken basalt candlestick and some fragments of a bronze candle snuffer. The first documentary records of Mykines date from 1584.

One blessing that Mykines offered was security from enemies. The population of the Faeroe Islands has never been large enough to defend itself from marauders, and in former times there were many. During the fifteenth and sixteenth centuries, English fishing boats were not above stopping at the Faeroe Islands on their way to the Iceland banks and helping themselves to sheep or seizing islanders for unpaid service on board. In the seventeenth century, pirates—even Barbary corsairs from Algeria—became a menace. Many Faeroese villagers cunningly concealed refuge huts in the mountains and hid there while their homes were pillaged.

Mykines, however, was safe from such terrors. On the north and south, the island is protected by sheer cliffs that rise 1,300 feet or more out of the sea. There is no beach, and it is difficult to imagine how any landings could have been made here before the jetty was constructed.

For the traditional subsistence economy, Mykines was well en-



Because wood is virtually nonexistent on the wind-swept islands, most buildings are constructed of concrete or corrugated metal. Settlements, such as Sörvágur, at left, are nestled deep within protective fjords. On Mykines, puffins used to form an important part of the islanders' diet. Now, the birds are netted as a form of recreation.

dowed. Every visitor to the island is impressed by the greenness of its fields. The unusual fertility is produced by the droppings of hundreds of thousands of birds—guillemots, puffins, kittiwakes, razor-billed auks, gannets, petrels, and arctic terns. Through subsistence methods of farming, the lush grass could carry 40 cows and 800 sheep through the winter.

In summer, the fields around the village are a patchwork quilt of tiny grass plots—some freshly mown, others grown up in rich hay. This is the result of an incredible subdivision of ownership. On Nólsoy, ownership was rationalized a few years ago by means of the Faeroese enclosure laws. On Mykines, enclosure has not been worthwhile, and the cultivated land remains a complex of tiny strips, many owned by nonresidents.

A five-foot-high dry wall protects crops from being consumed by the moorland sheep. The gates in the wall are thrown open every October 25, after harvest, and the sheep surge in to graze over the fields. They are rounded up each May 14 and driven back to their summer pastures and the gates are once again closed.

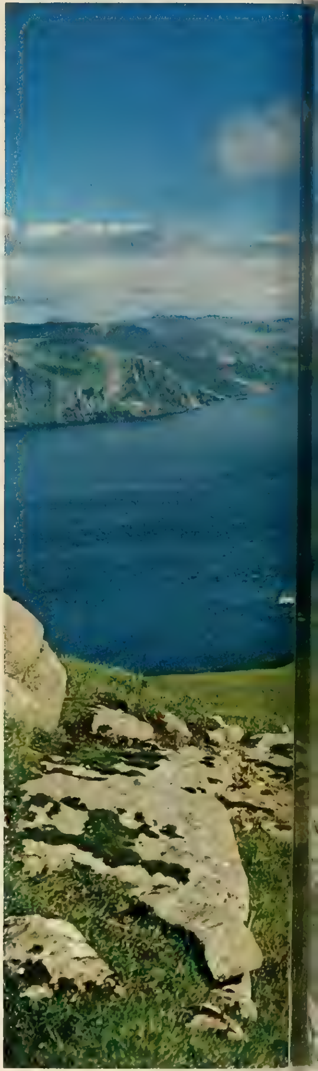
Cattle graze just outside the wall during the summer, but they are brought inside the village and kept in small outbuildings for the winter. Nowadays, on Mykines as elsewhere in the Faeroe Islands, beef cattle are preferred to dairy stock. The task of searching out the cows for milking every morning and evening seems unnecessary when sterilized milk imported from Denmark is so cheap.

Sea birds used to be an important factor in the Mykines economy in former centuries. Even today, the hunt is carried on with enthusiasm. Traditionally, the most frequently hunted birds were puffins, guillemots, and gannets. Recently, fulmars have also become popula

Gannet catching is peculiar t Mykines, as the only Faeroes gannetry is situated on the wes ernmost cliffs of the island. Th breeding stock is said to vary be tween one and two thousand pair Gannet is tasty—like a fat goose.

Puffins are hunted with nets, a extraordinary method requirin speed and timing. Using a V shaped net at the end of a twelve foot pole, the hunter conceals hin

Knowledge of traditional occupations is handed down from generation to generation. Each spring, children are encouraged to lend a helping hand when sheep are herded into corrals for shearing, but instruction is usually informal. After shearing on Mykines, the sheep are let out of the gates of the village and left to graze for the summer on the island's lush expanses.

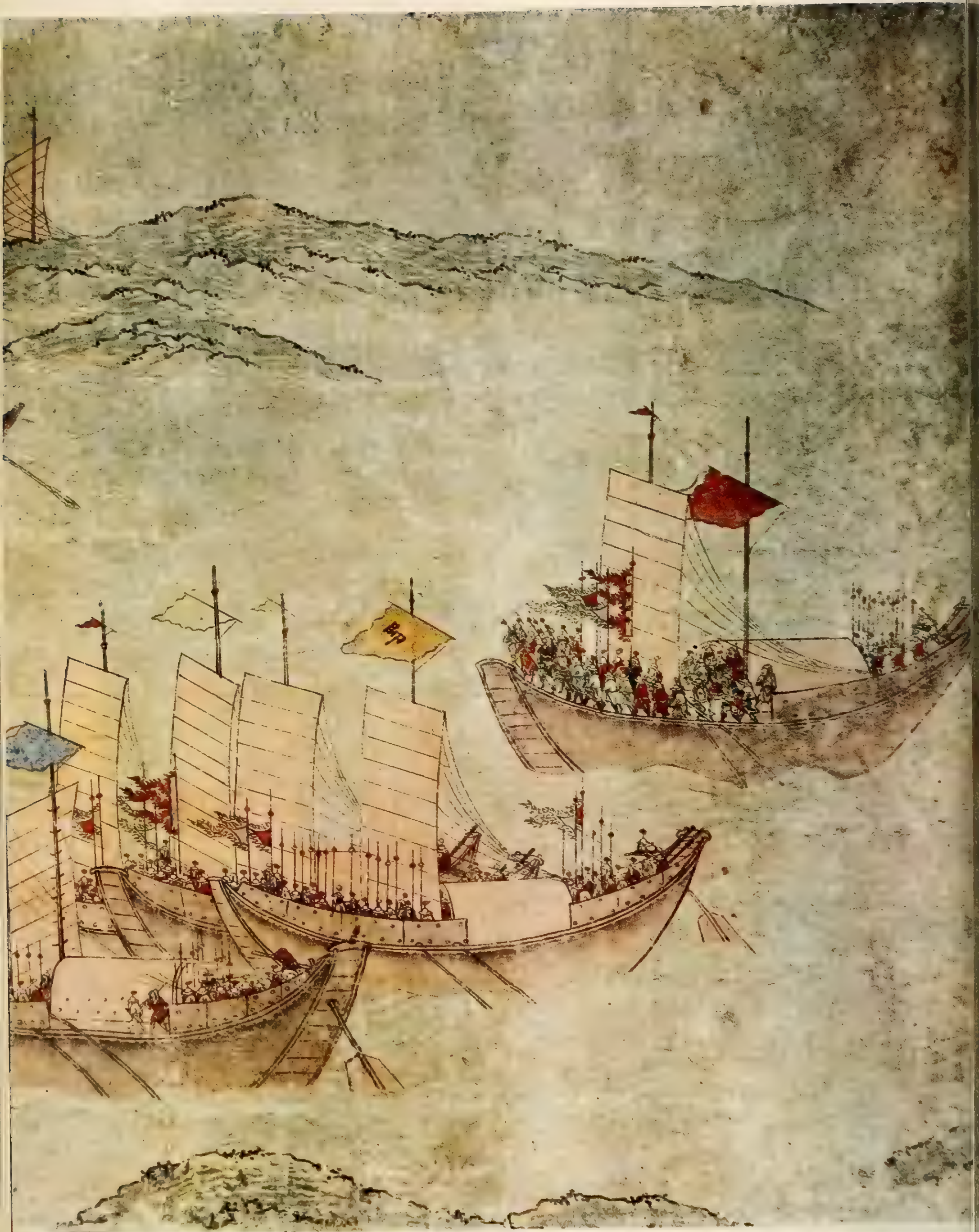


lf behind one of the low, dry one walls built for this purpose ar the large breeding ground just est of Mykines village. When the ffins fly past, the hunter swings e net up so as to take them from hind.

Most Faeroese families take ide in being at least partially self-fficient, and their basements ill always have some puffins or lmars salted away, in addition barrels of pilot whale meat and sacks of home-grown potatoes.

At least some of the cultural heritage of the Faeroese village will live on into the modern age. But the very existence of the Mykines community hangs in the balance. Two tiny hamlets on the nearby island of Vágar have already disappeared, as have several small villages on islands in the northeast. A dozen other outlying Faeroese villages are likewise threatened. With the ever declining population of Mykines, the day may come when there are not enough able-bodied men for the spring and autumn sheep roundups.

The values and skills cherished over the centuries in villages such as Mykines may, to some degree, continue to influence the modern, urbanized Faeroese, but given the present trend, within a generation a way of life rooted in the Viking culture of a thousand years ago may be a thing of the past. ☐



Collection of Hing-tsang Lee, photograph by Wan-go Weng

BY STAN STEINER

CHINA'S ANCIENT MARINERS

The sea comes to an end somewhere in China . . . .
Anonymous Roman author, A.D. 100

Long ago in China, there lived a father who had two sons. Ie was a merchant. So were they. Whenever he sailed across ne seas to trade in far-off countries, he would ask his sons to ccompany him. On one of these voyages, a terrible storm ngulfed their ship; the waves tossed the ship so violently that ne father and his sons feared they soon would be drowned. ut the youngest daughter of the family rescued them.

She was a mere seven years old, but she already possessed upernatural powers. Although she was at home, the little girl ensed her father's and brothers' danger. And so her soul left er body and flew like a bird over the turbulent waves to the inking ship. Sweeping down from the sky, she grasped one rother in each fist and her father in her mouth and flew away) safety.

When the little girl's soul had left her body in her father's ouse, her physical being became empty and limp. On seeing nis, her mother began to comfort the child and fondle her old limbs.

“Are you all right?” her mother asked.

When the little girl opened her mouth to answer her nother, her father fell out of her mouth, his body dropped nto the stormy seas, and he drowned.

“You,” the little girl angrily told her mother, “are to blame or the death of my father!”

Then sorrowfully, she told her mother how her soul had own out to sea to rescue her father and her brothers on the nking ship. And how she had saved their lives. But because er mother had been so worried about her physical being, she ad opened her mouth to comfort her, and in doing so, her ther had fallen from her lips into the seas and died.

In 1592, the Ming dynasty's long reign (1368–1644) was marred by the Japanese invasion of Korea. Facing page, a Ming ship under full sail (at right) successfully repels Japanese vessels.

"Is it really true?" her mother asked.

"Look, my hair is still moist from the sea," the little gi
said. And seeing this, the mother wept.

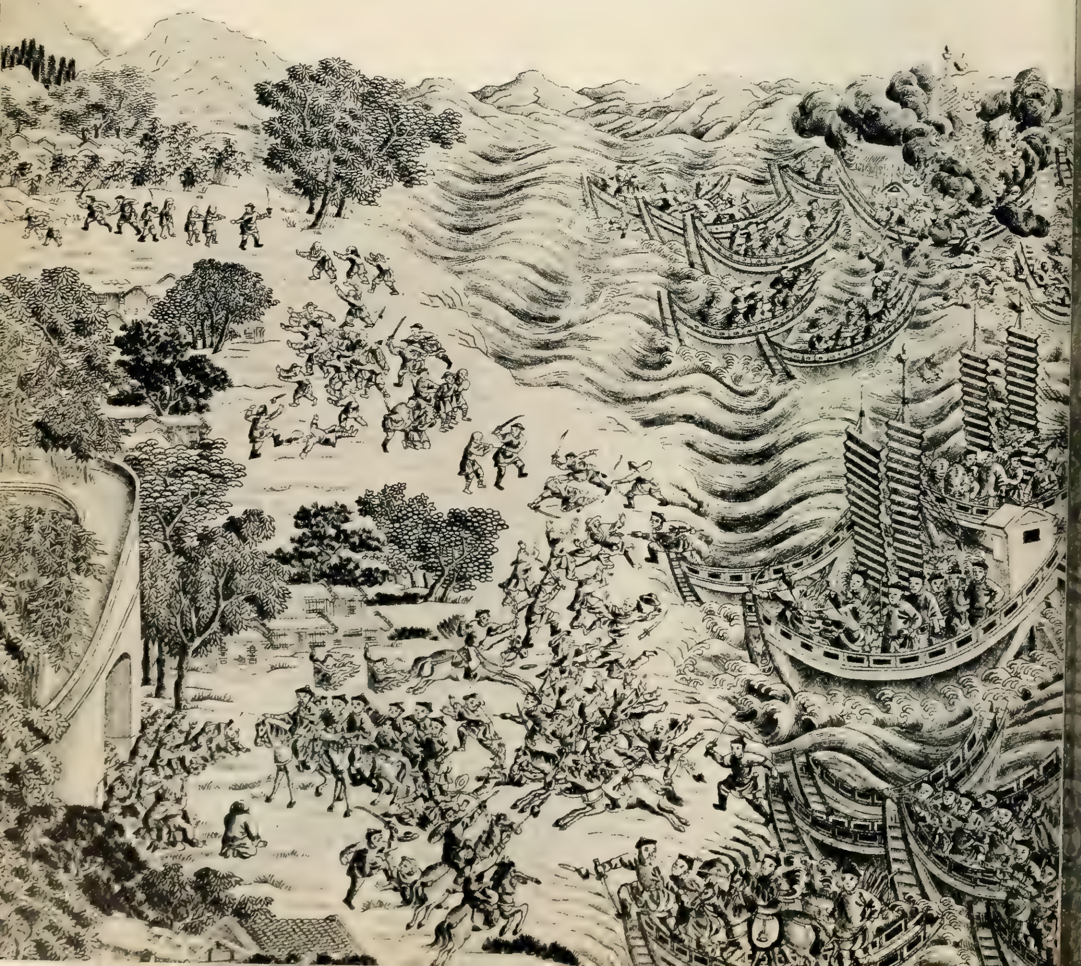
Compassion now filled the heart of the child. Her anger le
her, and she grieved for the sorrow of her widowed mothe
She took an oath never to marry. And until her mother die
the youngest daughter cared for her. She was as selfless as
daughter should be.

She became an immortal known to all as T'ien-hou, god
dess of the sea, protector of ships and seamen on all th
oceans of the earth and all the rivers of China.

And it was said she even became an empress of Heaven

That is why all along the Fukien coast of China, one of th
most sacred and popular of deities has been T'ien-hou. H
cult spread throughout southern China. Her worshipers ca
ried her legend across the Pacific to the shores of Americ

In 1788, rebel forces from south and central Vietnam occupied Hanoi, and the emperor appealed to China. Below, a Chinese fleet sent by the Manchu emperor lands cavalry to quell the rebels.

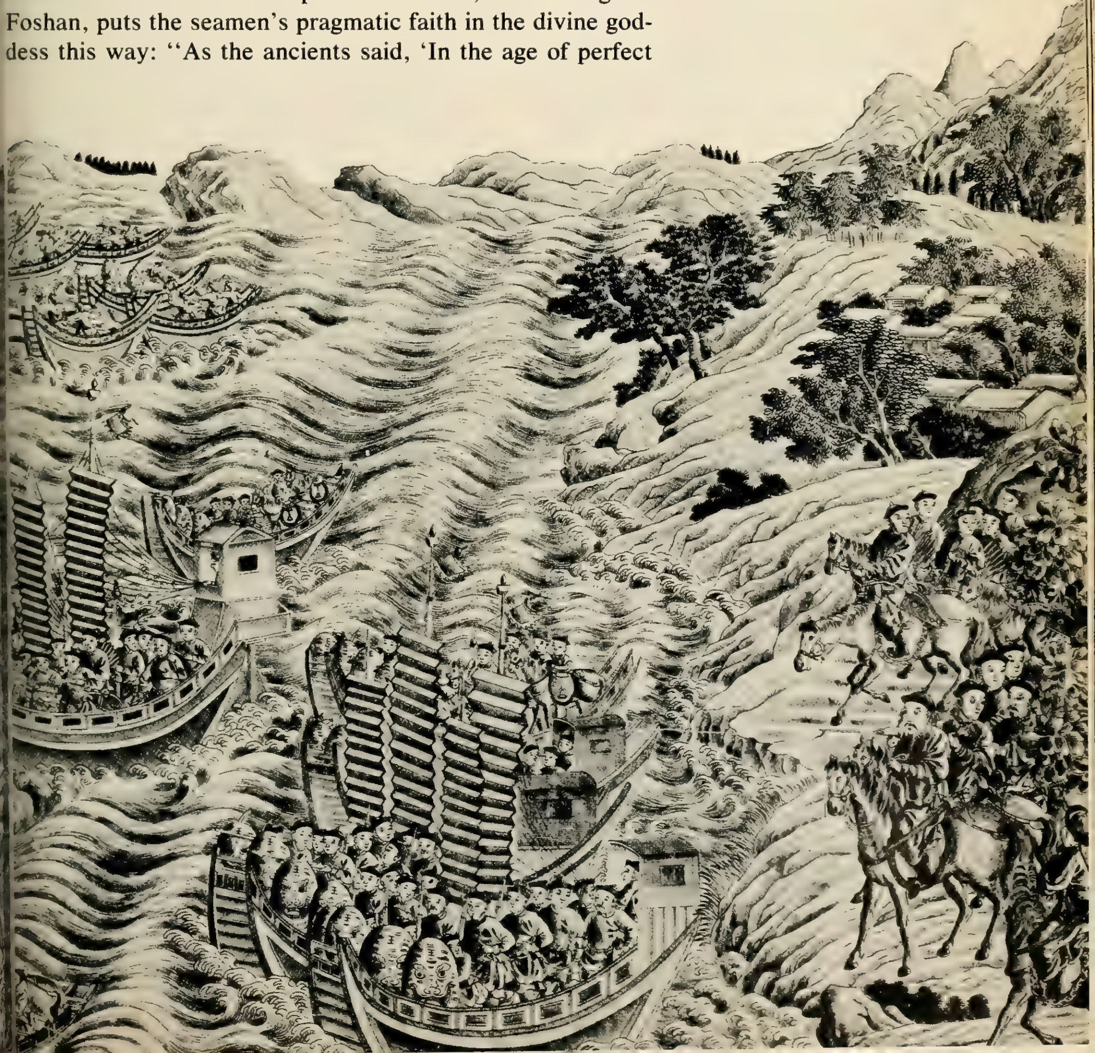


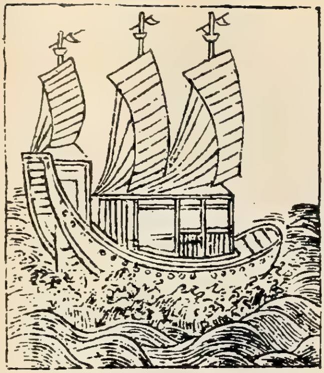
And they built temples for T'ien-hou in many of the Chinatowns of California.

Some of the writings celebrating the powers of the goddess of the sea are known to date from the tenth century A.D. and there are some writers who trace her origin to the third century B.C., to the river goddess of Wushan. Sung Yu in *Fu of the Goddess* tells of the dreams of the emperor Hsiang (298–264 B.C.) in which the goddess is described as the source of the rain and mist. But her deification and worship may be much older, as old as the earliest fishermen and seamen of tribal China, who sailed the rivers and seas before the beginning of written history. And, if so, who was T'ien-hou? Where did she come from? Why was she so powerful?

A sacred tablet in the temple of T'ien-hou, in the village of Foshan, puts the seamen's pragmatic faith in the divine goddess this way: "As the ancients said, 'In the age of perfect

The Library of Congress, Washington, D. C.
Photograph by Wan-go Weng





An early-seventeenth-century woodcut portrays a ship from the navy of Cheng Ho, the Ming dynasty's eunuch admiral. His fleets explored Java, Ceylon, Malacca, and the coast of India and reached the Persian Gulf, the Red Sea, and East Africa.

Mao Yüan-i, *Wu-pei chih*
Photograph by Wan-go Weng

government, the spirits become unnecessary.' " But at sea, "when the Way of Man fails to do right, the spirits and the gods come into the light."

Was she a mythic sister of the great goddess of the seafaring Pelasgians of pre-Grecian tribalism? Or was she the daughter of the mother goddess worshiped by the ancestors of Phoenician seamen and described by the second-century Roman writer Lucius Apuleius, in *The Golden Ass,* as having "risen from the midst of the sea" to guide "the seas' winds," and whose "true name" was Isis? The worship of these goddesses may be as ageless as the fears of the first tribal seamen—and seawomen—who needed guidance on the unknown seas.

Even older, her lineage may be in the darker beginnings o the sea, going back to the earliest worship of water. In th Shang dynasty (mid-sixteenth to early thirteenth centur B.C.) a god of Ho (the Yellow River) lived like a drowned ma beneath the water. In times of flood and storm, he wa calmed by the gift of a young girl who, upon a raft for a brida bed, was given to him in marriage. In his palace of fish scale and cowrie shells, she became goddess of the river, while o the shore the people sang her wedding song, 3,500 years ag

Oh, you mount a white turtle!
  your robe is a striped fish!
Oh, I wander at your side!
  in the corridors of Ho!
Oh, we combine our hands!
  as we travel to the East!
Oh, waves in steady surges!
  come to welcome us!

The symbol of the dragon as a giver of life is not sole Chinese, but it is particularly so. And what is a dragon but great fish with feet; a serpent with wings. In China, this aw some and powerful creature was not a bringer of knowledg and evil, as it was in the Garden of Eden in the West; rather brought fertility and abundance, which was knowledge ar wealth. It was a magical fish that created human progeny; th legendary father of Heaven of the legendary emperors.

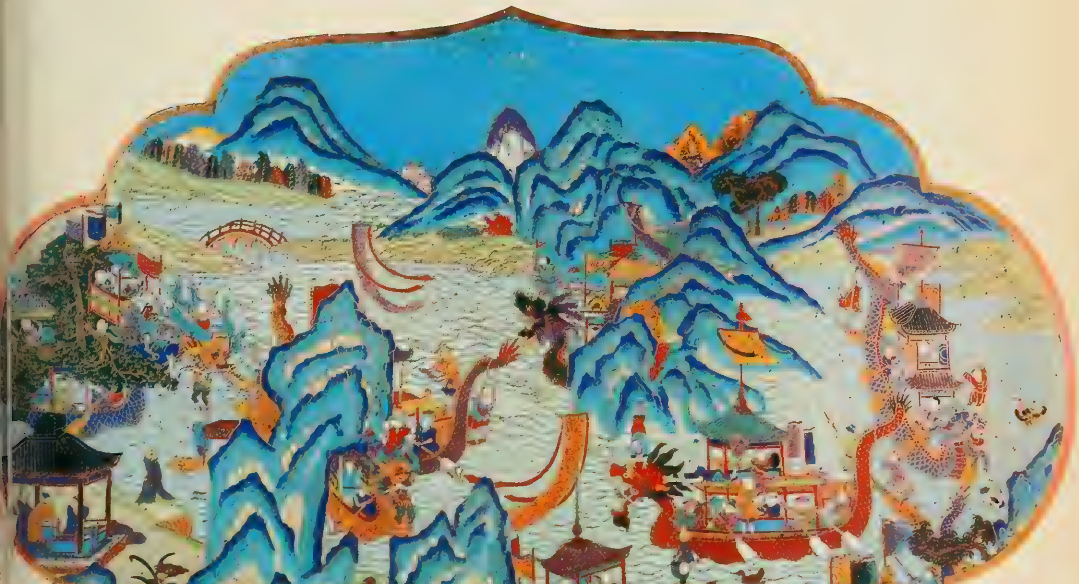
And in the oldest of the older legends, the heavenly drag was often a woman, a young woman. She was at times innocent girl or the forsaken virgin or the bride abandoned the altar, who went forth as a dragon to bring her lover ba from the seas. T'ien-hou, the goddess of the sea, might be t daughter of that dragon.

The origin of Chinese civilization may owe more to t importance of fishing on its rivers and its seas than has ev een recognized. Fish were an essential food of the "nulear" civilization of northern China, writes Kwang-Chih hang in *The Archaeology of Ancient China* (1971). Chang ays that some authorities on early Chinese history have ome to believe that "the birthplace of farmers and herders" n ancient China was in that cradle of land at the confluence f the northern rivers, the "habitat for the sedentary wateride fishermen" of Neolithic times. Here was the origin of the distinctive pattern" of the Chinese civilization's "indeendence and originality."

Fishing may well have provided ancient peoples with an asier and more accessible source of food than hunting. The ong coasts and longer rivers of China offered a natural reseroir of fish. Both in the folklore of the ancient fishermen and n the scientific lore of modern archeologists, there is evience of the importance of fishing not only for the survival of he people but also in the creation of their character.

In Honan Province, caves of the Yang-shao civilization ave been found filled with towering heaps of fish bones. hese ceremonial and culinary mounds date to 3000 B.C., and efore. And on the banks of the Yellow River and its many

An eighteenth-century cloisonné box cover shows a seascape and dragon boats in the earlier T'ang style (618–907). The scaly dragon, giver of life, is really a giant fish with feet. The Chinese sea goddess is thought to be the dragon's daughter.

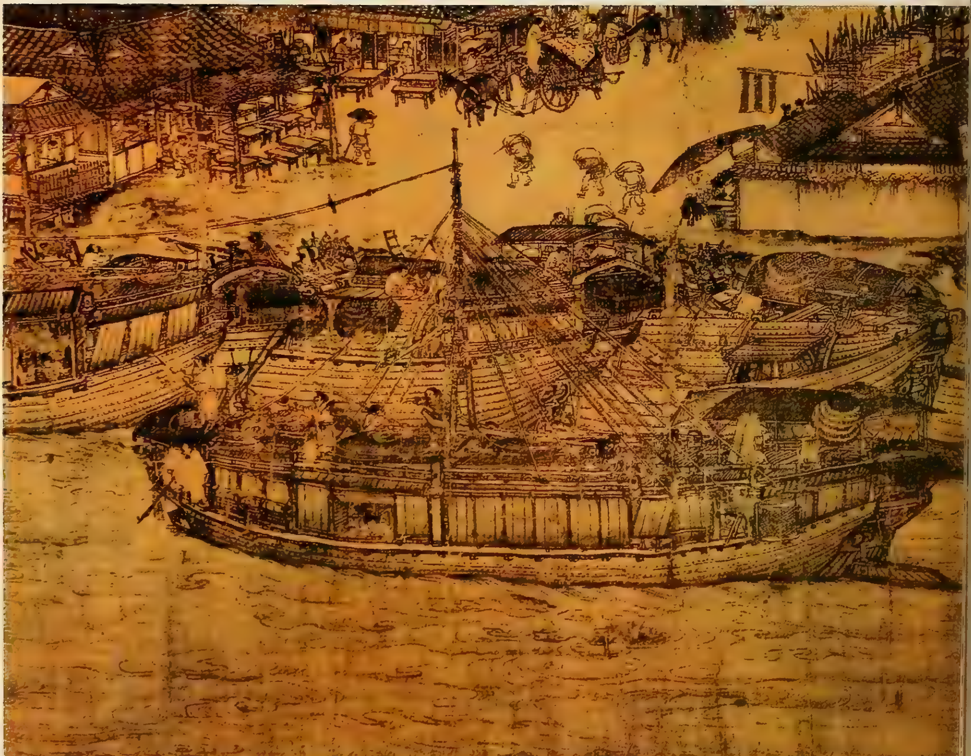


The Avery Brundage Collection, photograph by Wan-go Weng tributaries, fishing, a source of myth and food, was a highl skilled Neolithic industry. The symbolic significance of fis in early Chinese history is extraordinary.

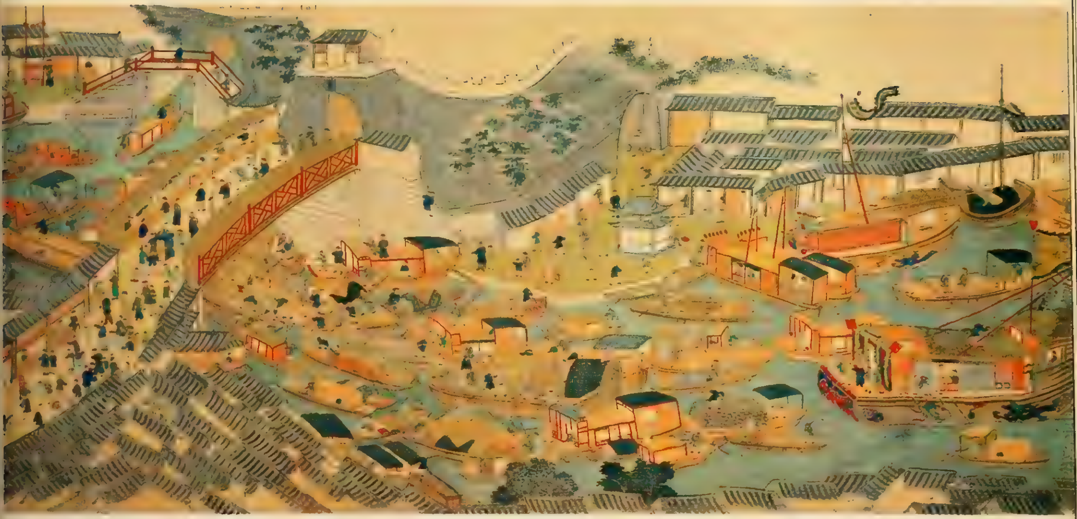
''In subsequent centuries, down to the modern period stories of the miracles of T'ien-hou continued to be told b sailors returning from dangerous voyages up and down th China coast,'' C. K. Yang writes in *Religion In Chinese Society* (1961). The Chinese seamen were ''among the most adventurous and self-confident'' of explorers but their belief i the ''magical practices'' of their goddess of the sea was so ol that it began long before the ''dawn of history.''

No one knows how long ago the tribal fishermen and seamen of China set sail. There is no written history of thei journeys or much archeological evidence of their way o living, as there is of hunting tribes. On the seacoasts, th boats and tools of seafaring peoples were vulnerable to wave and weather; they were not as well preserved as the fires an tools of hunters, deep within caves where even the pollen c flowers has been preserved after a hundred thousand year

An early twelfth-century scroll painting of a festival in the Sung capital depicts bustling river traffic. Under the Sung (960–1279), China's navy first became important.



The Palace Museum, Peking; photograph by Wan-go Weng



llection of Wan-go Weng; photograph by Wan-go Weng

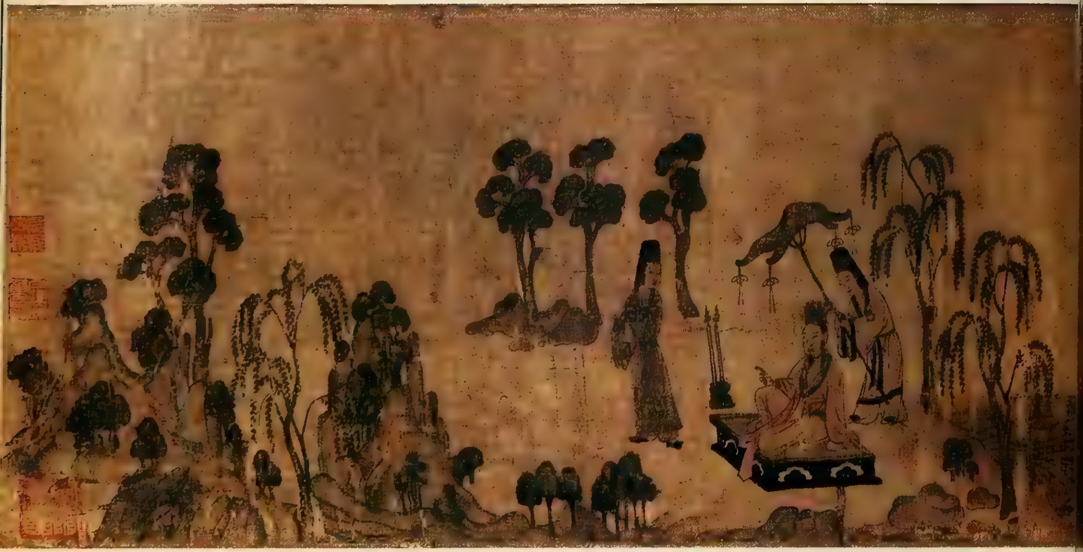
In a seventeenth-century scroll painting, the river in Soochow, one of southeast China's largest cities, teems with barges, transfer vessels, fishing boats, and pleasure yachts.

he rafts of logs and boats of reeds, the dugout canoes and
imitive sails have vanished.

The sea has never been gentle with the memory of its dead.
buries its conquerors and victims indiscriminately and with
ual grace.

Still, upon those glacial blue waters of the Ice Age, blown
/ stormy trade winds, there is evidence of Stone Age sea-
en in Asia who sailed forth on incredible voyages. They
aved the turbulent waves as courageously as their tribal
ntemporaries who walked across entire continents. They
ossed the oceans, leaving the details of their voyages in
gends and on stones that we have just begun to decipher,
r we could hardly imagine the skill, or measure the daring,
our ancestors.

On the islands of the Pacific there are still sailors who re-
ember the nearly forgotten science of the ancient mariners.
seeking to record their dying science, the Australian an-
ropologist David Lewis has explored the ways that islanders
ınaided by modern navigational equipment [traveled]
eat distances on the open sea." His journal, *We the Navi-
tors: The Ancient Art of Landfilling in the Pacific* (1975),
s been described by a fellow Australian, anthropologist
ephen Harris, as listing the navigational guides of ancient
afarers from "the more obvious ones of sun and moon posi-
ns, positions of the zenith stars, land loom, cloud lore,
ming birds, sea marks and wind direction, but also the less
vious features of swell orientation, wave refraction pat-



Freer Gallery of Art; photograph by Wan-go Weng

One of China's most popular deities was the sea goddess. This twelfth-century Sung painting on silk depicts a local water deity, the nymph of the Lo River. Her impressive entourage includes a multidecked ship like those dispatched by the Sung to trade with Korea, Japan, and the Arab world.

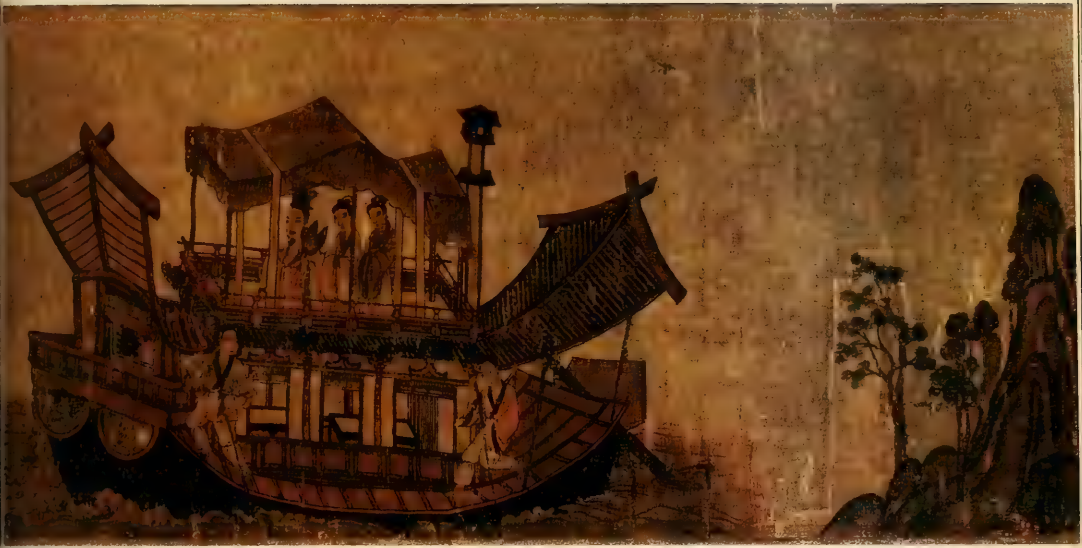
terns, wave shapes, deep phosphorescence and current spee
and direction.''

The islanders, even today, can sail for great distances u
ing their sea and sky technology. One of these contempora
''ancient'' seaman is said to know a world of navigation th
spans an area 2,600 miles wide.

The ancient Chinese and Japanese mariners were surely
less, and perhaps more, skilled. The earliest known voyag
of the seamen of the Asian continent seem remarkable
length and duration. But they were not. In the most dista
times, seamen sailed the seas as far and as freely as tho
whose later voyages happened to be remembered on pape
And we are beginning to decipher their legends and stones,
recognize and appreciate their accomplishments.

In recent years, archeologists have been startled by the d
covery on the shores of the Americas of pottery resembli
the Jōmon ware of Neolithic Japan. The thought that Chine
or Japanese ships may have reached the coasts of Ecuad
nearly 5,000 years ago was baffling. The pottery could ha
been traded from island to island across the Pacific, but th
would indicate the existence of Neolithic trade routes, tho
sands of miles long, across the world's largest ocean.

In ancient Mexico, signs of oceanic contact between t
Stone Age tribes of Asia and America have also been
earthed. The evidence of a possible Chinese influence on t
art and ritual of the Olmec culture has long been a source

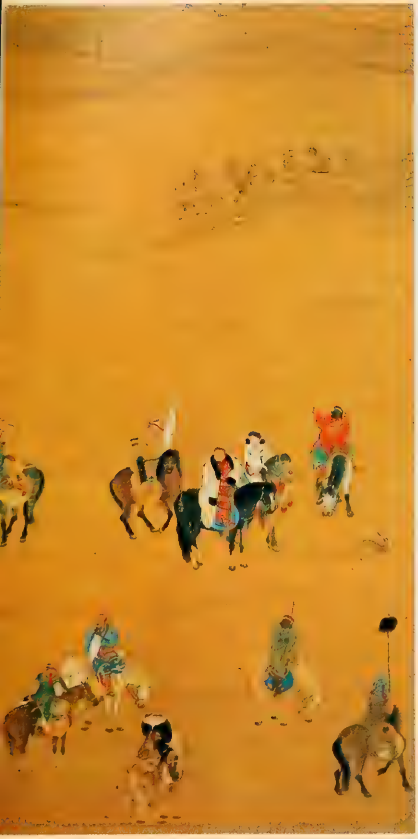


vonder for Mexican archeologists. As Miguel Covarrubias emonstrated in *Mexico South* (1946), even the spiritual use f jade was similiar in both cultures.

China itself may have been subject to "disturbing influences from] as far afield as the arctic coasts of North America, cenral and southern America, and the South Pacific, in late preistoric times," declared William Willetts, in *Chinese Art*. he effects of such influences on Chinese culture have long een debated, but to Willetts the findings of archeology suported a belief in Stone Age crossings of the Pacific Ocean. n any event, "the implications are evidently highly revarding." These surprising discoveries confirmed possible ranspacific contact as long ago as 3000 B.C., or before. In the ineteenth century, such historians of the West as Hubert H. ancroft and Charles W. Brooks were less cautious. They oldly believed that early explorers had crossed the Pacific cean in both directions.

Speaking before the California Academy of Sciences, in ay 1876, Brooks said: "Great maritime empires existed in ery remote times. And both Atlantic and Pacific Oceans vere crossed, and races and civilization widely extended in ges still called prehistoric. A knowledge of the western hores of the American continent has long existence in both hina and Japan. That a restricted communication has existed y sea across the Pacific does not admit to question."

To cross such vast and uncharted seas, in small boats of



In 1279, the Sung capitulated to Mongol invaders led by Kublai Khan, shown hunting in this fourteenth-century ink drawing. The Khan's navy astounded Marco Polo, and Mongol fleets of huge junks traded with Genoa and Venice.

National Palace Museum, Taipei
Photograph by Wan-go Weng

primitive design, required a knowledge of geography an
astronomy that could only be acquired by years of experience
Perhaps by generations and centuries spent upon the sea. Bu
these were rough and robust men, skillful and knowing i
mastering the discontents of winds and waves.

More than that, these earliest seamen had to learn the character of the sea. They had to be both daring and bold, stoi
and cautious, as people of the sea have been throughout history. The character of the sea had to become their own.

And what of their shipbuilding skills? They sailed forth o
seagoing canoes dug out of huge Neolithic trees and on grea
rafts of reeds and on flat-bottomed boats made of tied logs
Many similar boats of contemporary tribal people are large
than those of European explorers who ''discovered''
America and Africa and Asia. Most likely the ancient boat
of the Chinese were as large as, or larger than, the mor
famous ships of the Renaissance.

In classical times the Chinese were already building massiv
junks that could cross oceans. These heavy, ornate seagoin
vessels were known to have reached South Asia before th
birth of Christ. ''For upwards of twenty centuries the Chines
junks have been known to be large, fast and strong, the
people skilled mariners, excellent carpenters, and marin
architects. They early possessed mechanical skill to buil
junks of comparatively great tonnage, capable of conveyin
large amounts of cargo and great numbers of passengers,
wrote Brooks.

These early junks rivaled the ships of Arab caliphates. I
the fourth century A.D., sea voyages lasting months were r
corded, during which the crews survived thousands of mil
at sea before reaching port. The mastery of the sea by thes
men, ''may account for [ancestral China's] skilled boatme
who have lived upon the water from time immemorial, ar
for the enormous fleets of junks, generally of large dime
sions,'' thought Brooks. ''A taste [for the sea] early cultivat
may have come down through many centuries.''

One of the earliest emperors of the Ch'in dynasty, 221
206 B.C., sent a fleet of seagoing junks to the Isles of the Ir
mortals in the Eastern Sea. We now believe that these ma
have been the islands of Japan, but there is no one who ca
say they were not the Solomon, or the Hawaiian, or th
Aleutian islands.

No one knows the islands of the Pacific by the names th
the early Chinese seafarers knew them. So all we can say f
certain is that while the scholars argue about their geograph

ocation, the sailors and traders of the Ch'in empire simply ailed to them, and in celebration of their daring gave these slands names so poetic that we shall never discover them pon our prosaic, precise scientific maps.

Just as the seas flow many ways, so do the ships that sail pon them. When the Roman emperor Marcus Aurelius ought the silks of China he sent a fleet of traders to buy them. t is said that these Roman merchants reached Asia in A.D. 66, "going around Arabia and across the Indian Ocean." It vas evidence, wrote one historian, "that the sea route from he West to China was already in operation" at the time of he Caesars. Recent discoveries of Roman lamps and trading oods in the seacoast cities of Thailand confirm the extent of he trade between Europe and Asia in the earliest years of the hristian era. The sea route was a well-traveled thoroughare.

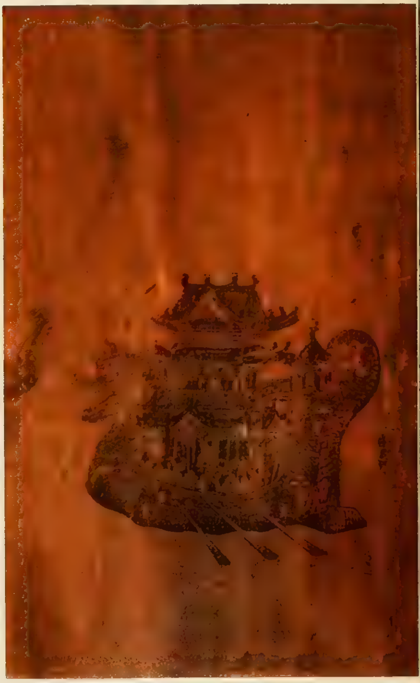
No Latin or Greek equivalents exist for the names the hinese gave the envoys of the Roman emperor; but they vere recorded by the historians of the Han dynasty. The hinese were suspicious of the Roman merchants and loubted their credentials. So the Roman emperor sent a second fleet of traders with convincing credentials, and the Han mperor diplomatically sent an envoy to Rome; unfortuately, he died during the long voyage to Europe.

It was not an expedition for the weak—in mind or body. ne Chinese traveler, Fa Hsien, who journeyed to India in .D. 399, described how he sailed back to China by way of ava, and how the sea captain lost his way in the China Sea, o that this ship sailed for seventy days before land was ighted—a longer voyage than that of the Mayflower more han a thousand years later.

Even so, for centuries the sea trade to China was domiated by foreigners. By the sixth century, Roman, Egyptian, ersian, Indian, Arabian, and Jewish merchants and seamen rowded the harbor of Canton, making it one of the world's argest and most cosmopolitan ports. But in A.D. 727 a T'ang istorian reported that the "Posse [Persians] sacked and urned the city of Kwang-chou [Canton]," as the Arabs had lone, and would do again. Infuriated, the T'ang emperor anned foreigners from the city. But, on second thought, he aunched a vast shipbuilding program that was to create hina's greatest merchant and naval fleets.

By the Sung dynasty, the Chinese navy had grown to hunlreds of ships: an impressive armada larger than the Renaisance navies of Spain and England. The fleet was manned by

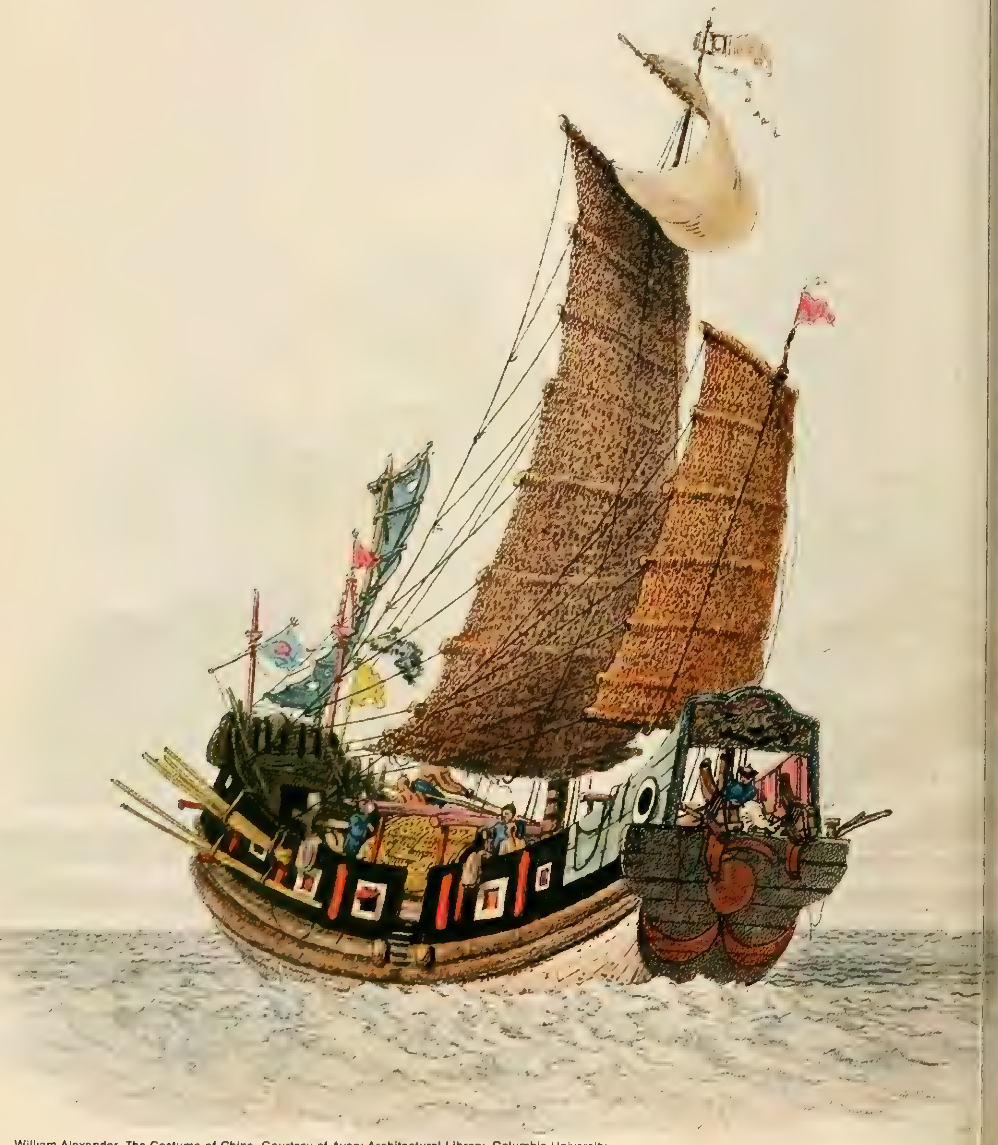
A fourteenth-century ink-and-wash drawing depicts a dragon boat, part of a Sung regatta. These palatial ships could carry hundreds of passengers and crew.



Metropolitan Museum of Art
Photograph by Kay Caranicas

This illustration of a Chinese trader appeared in a book that the British ambassador commissioned and presented to the Chinese emperor in 1792. The hold of a vessel of this type was divided into several partitions so that, in the event of a leak, most of the cargo was protected.

52,000 sailors. The seagoing junks of the emperors of Sun were built at this time—huge vessels that could hold six hundred people and "a year's supply of grain." Chou Ch'u-fe described these junks as being "like houses," with sails "lik great clouds in the sky." The cargoes of these junks, as liste in the *Annals of the Sung* in the year 999, included export and imports of all sorts, from rhinoceros horns to steel-plate armor. The geographers of the emperors had learned enough



William Alexander, *The Costume of China*. Courtesy of Avery Architectural Library, Columbia University.

ven by then, to describe faraway lands such as Somaliland, rabia, and Sicily, and the dragon-shaped ships were becomg known far into the Western seas.

These enormous junks must have seemed an apparition to esterners, who first saw them when the Great Khan, Kuai, sent an entire fleet to bring a Mongol princess to her yal wedding in Persia. In some disbelief, the Chinese junks ere described as having four to six masts, fifty to sixty abins separated into watertight compartments for safety, as any as ten lifeboats on board, and two or three supply boats tow, with room on their decks for vegetable gardens for the undreds and hundreds of passengers and crew.

To Europeans the Golden Horde is remembered as the orsemen of the Khans who swept across the steppes of Asia the very banks of the Volga and the Danube. They were ne of the most brilliant and victorious land armies in all of istory. Less known were the maritime exploits of the Khans, r these were less triumphant.

Soon after the Mongol conquest of the Sung empire, Kulai Khan commanded the Chinese fleets to invade Japan. A aval force of 900 ships and 25,000 men tried in 1274, and ied again in 1281, with 600 newer ships and 140,000 men. ut the Kamakura shogunate of Japan and the god of weather, ho unleashed a typhoon, combined to all but destroy the eets of the Great Khan. Nor were the fleets sent to conquer hat is now Vietnam and Java any more successful or any ss spectacular. On the sea, as on the land, the Great Khan ished to be second to none. Even his defeats were legndary.

By the time that Marco Polo arrived at the court of the reat Khan, the Mongol-commanded Chinese fleets on the angtze River alone were so numerous that the traveler from enice wrote in amazement: "The amount of shipping it [the ver] carries, and the total volume and value of its traffic, xceeds all the rivers of the Christians put together, and their eas into the bargain." On coming to the port of Sinju (Ihing), Polo saw 5,000 ships "in the harbor at once." The eaports of China were "a marvel to behold" he wrote, most f all Zaiton (Ch'uan-chou), which another European aveler, Odoric of Pordenone, described as twice as big as ome. An Arabian chronicler, who visited Ch'uan-chou not ng after proclaimed: "The harbor is one of the greatest in ne world. No! I am wrong! It is the greatest!"

Of all the feats of Chinese seamanship none surpassed the oyages of the eunuch admiral of the Ming dynasty: these ''seven voyages of Cheng Ho'' equaled the adventures Sinbad.

Emperor Hung-wu, founder of the Ming dynasty, ha decided to extend Chinese mastery of the sea as far west his fleets could sail. His successor, Emperor Yung-lo, cho Cheng Ho, the ''three-jeweled eunuch'' of the court, as th commander of the imperial fleets, to go into the western sea And though Cheng Ho had come from the inland province Yunnan, his seamanship was so exemplary, so skilled, that h will be remembered, along with Odysseus, Leif Ericsso, and Magellan, as one of the great captains of the sea.

In 1405, Cheng Ho sailed from Foochow at the head of fleet of sixty-three junks and 27,870 seamen. His flagsh measured 444 by 180 feet, as large as a modern ocean line. The fleet explored Java, Ceylon, Malacca, and the coast India, sweeping the sea of enemies throughout the India Ocean, before returning in triumph to China. From 1405 1433 seven of these royal fleets, actually armadas, sailed in the western seas. One of the greatest was the third fleet 30,000 men and forty-eight junks: the largest one carried crew of about 1,000; the average held 600 men. The fleets reached not only the Persian Gulf and the Red Sea (Aden, they captured a giraffe for the emperor's gardens), b the sixth fleet also explored the coast of East Africa, perha as far as Kenya.

Of his voyages Cheng Ho wrote, with no immodesty: ''T Imperial Ming dynasty, in unifying the seas and continent, surpassing the three dynasties even goes beyond the Han a T'ang. The countries beyond the horizon and at the ends of t earth have all become our subjects.'' The ships sailed 100,0 *li* (a *li* is about one-third of a mile), more than the now know circumference of the earth. ''Our sails, loftily unfurled li the clouds, day and night continued on their course, rap as a star, traversing the savage waves as if we were treading public thoroughfare,'' Cheng Ho reported to the emperor.

The last of the fleets had barely returned when the ma- darins of the court began to decry the extravagance of saili so far away, as is so often the opinion of those who stay home. No sooner had the emperor begun to doubt the wisdo of the sea voyages than Japanese piracy swept across the s like a scourge; it had been provoked by the invasions of K- blai Khan and the civil war raging between the warlords feudal Japan. One after another the ports of China were sack by Japanese pirates who attacked, not singly, but in rovi packs, year after year.

And so the Ming emperors enacted a decree prohibiting sea yages. The explorations of the vast fleets ended inglori-usly; an era of Chinese seamanship died stillborn. Within e century, European ships commanded the seas.

Since that time historians have wondered what might have ppened to the course of history if the emperors of the Ming nasty had not withdrawn their fleets from the seas and had iled down the coasts of East Africa and around the Cape Good Hope? And if, in doing so, they had met the smaller d lighter ships of the Dutch and the Portuguese head on? nd if they had gone farther into the Atlantic, north to the ores of Europe?

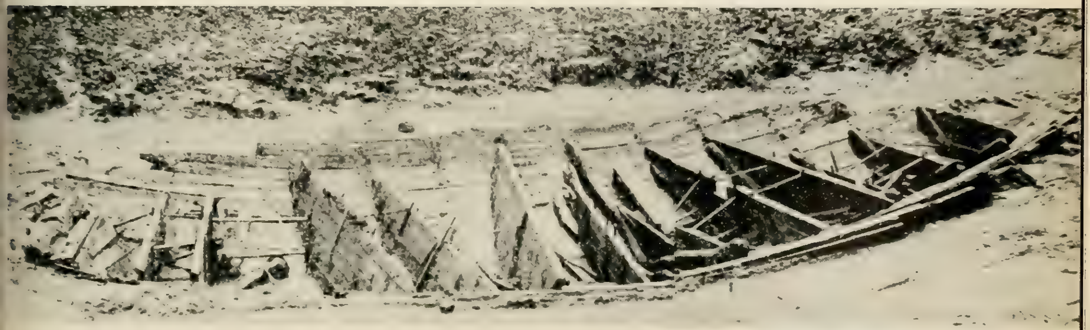
One thing is certain: the seamanship of these ancient Chi-se mariners refutes the myth that China was a withdrawn, ckward nation, living in self-imposed isolation. The mys-que of the mysterious Orient, inscrutable and secretive, as little foundation in the robust and raucous history of the as. If anything, the seamen of China seem to have opened any of the trade routes to the West, which Westerners then sed to reach China.

"No race [on earth] can compare with the Chinese in their pacity as traders, colonists, and pioneers," wrote Sir John ratt, in his history of the China trade.

"As far back as we can discern, the sea-borne trade [of hina] between the countries bordering on the Indian Ocean nd the China Seas exceeded many times in volume the petty affic of the Mediterranean world. . . . If their vessels never iled the Atlantic or the Mediterranean it was because, as h'ien-lung pointed out, China had no [need to] import manu-ctures of outside [namely, European] barbarians.

"The Chinese, like the British, are a seafaring race," Pratt id; and no Englishman could say any more than that. □

This 165-foot wooden ship, dating from the Sung dynasty, was recently salvaged from Ch'uan-chou Bay in Fukien Province, on the southeast coast of China. These remains barely suggest the magnificence of Sung ships, which often had as many as nine or ten masts, were as wide as a modern ocean liner, and were frequently 400 to 500 feet long.



Wen Wu Magazine, Peking No. 10, 1975

San Salvador's Urban Orchids

by Peter Bernhardt

In the trees of El Salvador's capital, orchids thrive, largely because the city's population ignores them

The Central American country of El Salvador is the smallest mainland American republic, roughly the size of Massachusetts. Nevertheless, like other political boundaries carved out of the Neotropics, El Salvador possesses an abundant native flora to delight and fascinate a systematic botanist. One Sunday, for example, I found two orchid species in blossom. These sightings were not made under especially romantic circumstances. I was not slashing my way through rain forest lianas or climbing a cow path on one of El Salvador's numerous volcanoes. I was walking down some of the busiest streets in the capital city of San Salvador.

The first plant was *Cattleya aurantiaca,* which produces small, star-shaped, red-orange blossoms. The plant was clinging to a telephone pole that overlooks five daily bus routes.

The second plant, *Oncidium cebolleta,* was brightening the fork of a tree growing in a school playground and bore a spray of flowers, each the size of a child's fingernail. The sepals and petals of *Oncidium* have a yellow finish marked with red-brown spots that undoubtedly give this orchid its common Salvadoran name of *chorizo con huevo,* "sausage and egg."

As far as San Salvadorans are concerned, the ten orchid species that adorn their streets are as useless as the wild, weedy plants North Americans associate with their own cities. No one takes care of dandelions, crab grass, ragweed, or ailanthus, "the tree that grows in Brooklyn." Yet they flourish under minimal conditions, regardless of whether city dwellers root them out or ignore them.

These plants are colonizers that benefit from the exposed soil of a disrupted or destroyed ecosystem, be it a fire-ruined forest or an abandoned lot. Their seeds germinate rapidly, and their growth pattern is typical of weeds: long, spreading stems; no woody tissue; dense, durable root systems; and anatomical and physiological adaptations that permit them to withstand environmental pressures from climate, animals, and insects. Most important of all, the energy that they glean from their habitat is almost completely directed toward their reproductive systems. Weeds' individual life spans are short—they flower and die—but several generations a year insure many offspring during the limited growing season. There is a penalty to be paid here, in the form of limited exchange of genes.

But the orchid may only comfortably survive in association with the environment in which the original seed was deposited. The family Orchidaceae belongs principally to climax ecosystems and old stable environments. The sunlight, water, and minerals orchids convert into life processes indicate slow maturation and feature complete adaptation to the subtle ties of their habitat. While a single orchid fruit may contain thousands, if not millions, of viable seeds, the plant may not be ready to flower for several years. Individual species rarely flower more than once a year. In the tropics, the blooming season of a single plant may last up to two months.

San Salvador is hardly Walden Pond. The population exceeded 350,000 in 1970 and increases annually by 3.8 percent. The city suffers from all the ills that plague other Latin American capitals—a large transient population; overexpansion, which threatens the water table; and environmental and hygienic abuses, ranging from the discharge of raw sewage into local rivers to the absence of air poll tion filters and noise control uni on automobiles and public tran portation. Yet in the face of a these obstacles, ten orchid speci appear to maintain standing pop lations here.

At 2,238 feet above sea level Sa Salvador is in the climatic rang that local topographers and met orologists call *el clima templac cálido*, the climate of the high central valleys. Sixty-six to se enty-eight inches of rain falls du ing the rainy season months of Ju through October, and the averag annual temperature is 75 degre Fahrenheit. Where natural veget tion has been permitted to remai plant geographers note that a lo altitude hot zone flora and a hig altitude cool zone flora coexist this area. The orchids of San Salv dor represent both floras. Speci such as *Oncidium cebolleta* a *Catasetum integerrimum* beg their range in the dry forests the Pacific coast. *Epidendru chacaoense, Brassavola cucullat Epidendrum adenocarpon,* a *Laelia rubescens* become co mon in the low valleys. All t other species are essentially co zone plants, but they do desce to the lower altitudes and meet t former orchids on equal terms the parks and side streets of Sa Salvador.

All urban orchids are epiphyt and exploit microhabitats that h man beings have no intention claiming for their own. They spe their lives clinging to the bark

A white orchid touched with gre and gold, Brassavola cuculla *blooms in San Salvador's par and side streets in June and Jul After dark, it exudes a fragran that attracts pollinating moth*

Kjell B. Sand

Kjell B. Sandved

trees, but unlike strangler figs and mistletoe, orchids never parasitize their hosts. The long, tangled root systems of epiphytic orchids encircle a tree's limbs to form a living net that traps rushing rainwater and holds dust and leaf debris used as a mineral supplement after being broken down by epiphytic bacteria and fungi. In this way, parks and tree-lined streets form islands of life in a sea of asphalt.

This principle also holds in the countryside. Roughly 30 to 40 percent of El Salvador's forests have fallen to cultivation. When forests are cleared for coffee (the country's most important export and greatest source of wealth), the orchids of the herb layer, such as the many species of *Spiranthes, Habenaria,* and *Sobralia*, vanish for good. But since the tallest trees are left standing to shade coffee bushes, many epiphytic orchids are given a reprieve. Local populations survive, if on a somewhat limited scale. One reason they last is that at the onset of the rainy season, Salvadoran farmers cut boughs of local tree and shrub species, strip the branches, and use them as stakes for barbed wire. Many stakes take root and put out new branches. Within a few years these living fences and windbreaks become hosts to orchids and other epiphytic plants.

Only a few centimeters of rain falls during El Salvador's dry season, November to May, but since dryness is a cyclical aspect of the climate, the native flora generally has evolved to deal with both the excess and absence of water. The leaves and shoots of all orchids are covered with a thick, waxy cuticle that retards evaporation. The leaf stem is normally swollen and globose, forming succulent, fibrous structures that botanists and orchid fanciers call pseudobulbs. During the height of the European orchid craze in the latter half of the nineteenth century, pseudobulbs, like the tuber of the potato, were believed to be the plant's true regenerative part. Deprived of their roots, leaf blades, and the shoot meristem, pseudobulbs prepared in this manner for export did not survive to produce flowers or more pseudobulbs. As its name implies, the resemblance between a pseudobulb and a true bulb is superficial. Like most species of cactus or South African euphorbias, orchids growing in dry places draw in water through their roots during the rainy season and store moisture in their pseudobulbs against long months of deprivation; however, orchids growing on trees in areas of high moisture may also have pseudobulbs because even if rainfall is plentiful, drainage on a tree limb is rapid.

Not only are El Salvador's orchids able to tolerate changes in climate; they are also able to thrive on a remarkable variety of cultivated and introduced tree species. I have seen the tiny-flowered *Barkeria chinensis* and the handsome *Epidendrum ciliare* and *Brassavola cucullata* forming massed colonies on Australian pines that line the road to the National Fairgrounds. The dense branches of the monkey puzzle tree support the heavily pseudobulbed *Catasetum integerrimum*. And on the grounds of the National University, sweetly scented bottlebrush plays host to naturally dispersed colonies of *Epidendrum adenocarpon*.

Orchids grow in parks, in playgrounds, along streets—in virtually any spot with trees. But along the banks of the Rio Lempa, where the homeless have cleared trees and vegetation out of ravines and put up cardboard, sheet metal, and adobe huts, no orchids grow.

While the situation has not been studied thoroughly, there do not seem to be many barriers blocking the fertilization of a city blossom. *Catasetum integerrimum,* for example, belongs to one of the few orchid genera with unisexual flowers. The plants are dioecious. Each plant produces either male

Cattleya aurantiaca *is a cousin of the large hybrids commonly used for corsages. Shaped like small stars, its reddish-orange blossoms grow in thick clusters on tree limbs over San Salvador's streets.*

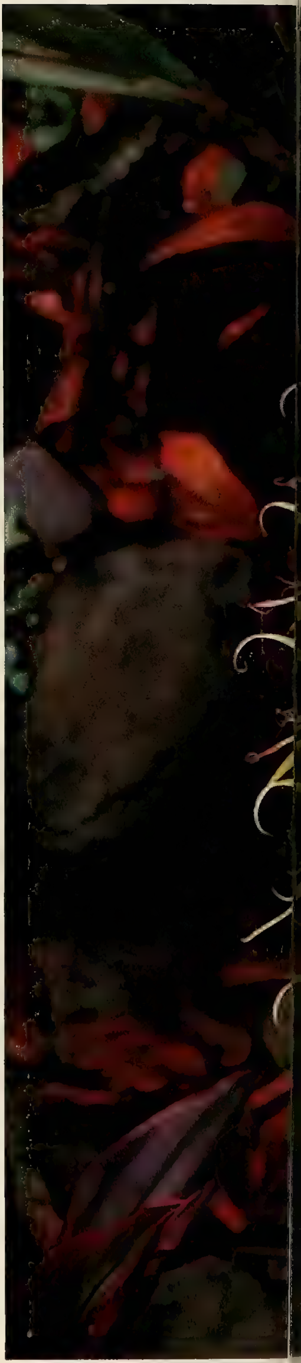
flowers (the anthers are fertile; the ovaries small and useless) or female flowers (small infertile anthers, functioning ovaries) and self-pollination is impossible. Instead, both male and female flowers exude a chemically complex, clovelike scent during the morning hours that attracts the large, furry *Eulaema* bee. *Epidendrum adenocarpon*'s fragrance smells like a mixture of orange blossoms and burned rubber. It draws small, solitary bees that transport the sticky pollen wads, known as pollinia, from flower to flower. *Brassavola cucullata* only exudes fragrance after dusk; its sweet perfume fills the night air and is believed to attract night-flying sphinx moths that carry the pollinia on their heads.

Moth-pollinated species of *Brassavola* and some bee-loving species such as *Epidendrum adenocarpon* offer insects the usual caloric reward, nectar, for their vector services. Nectar, a fluid consisting of well-diluted simple sugars, is a form of easily metabolized liquid energy. However, about half of all orchid species have no nectar. *Catasetum* and probably some of the urban *Epidendrums* fall into this category. Bees have been observed assiduously scraping the scent glands located on the flowers' epidermis and storing the perfumes in the pollen baskets on their legs. Pollination biologists used to think that these lazy male bees were "floral junkies," using orchids as easy fixes. But recent research suggests that bees use orchid scent to produce a pheromone essential to the completion of their life cycle.

The floral biology of one orchid, *Cattleya aurantiaca*, appears to have changed under urban conditions. In neighboring Guatemala, this orchid's red-orange color and half-open flower is typical of bird-pollinated species, and orchidologists suspect that *C. aurantiaca* is pollinated chiefly by hummingbirds. In Guatemala, probably thanks to a bee vector, *C. aurantiaca* also crosses naturally with the large, purple-flowered *C. skinneri*, resulting in a medium-sized, delicately scented, pink-flowered hybrid known as *C. x. guatemalensis*. But even though both *C. aurantiaca* and *C. skinneri* are found south of Mexico, I have not found in El Salvador the natural hybrid to which the two are supposed to give rise when they share a pollinator. The form of *C. aurantiaca* found in San Salvador fails to open completely: the irregularly shaped petal known as the labellum remains partially folded over the column composed of a single stamen fused to the pistil. The labellum also lacks the characteristic red dots believed to attract pollinators drawn to nectaries by visual cues. Yet every flower on the urban *C. aurantiaca* sets fruit. Presumably, although its pollinators are absent in the city, the orchid flourishes by self-pollination.

El Salvador's orchids, even those urban species that lack floral nectaries, have established a sophisticated relationship with the local ants. Below the flower bud of most species, on the flowering branch, but not on or in the flower, is an extrafloral nectary. Before the buds blossom, these nectaries excrete large, luminous drops of nectar, which are gathered by tree ants. The orchid's flowering branches remain free of sucking pests such as aphids. Further experimental work will reveal whether the ants studiously keep the branches clean on their own or whether the nectar is a bribe to keep the ants from tending their "cows" on the orchid's delicate flowers.

Seeding presents little problem for urban orchids. Parasites, such as mistletoe, and many epiphytes, including aroids such as philodendron and night-blooming cacti, produce fleshy fruits or seeds bearing oil glands or sweet, pulpy seed husks. These are eaten by birds, as well as by bats and other mammals. Some seeds are eventually defecated or regurgitated in fertile places, such as lichen-encrusted branches. This method of seed dispersal is alien to all orchids. Urban orchids, like their country cousins, have hard capsules, or pods. Orchid seeds are incredibly numerous and practically microscopic. They are so small, in fact, that one seed consists solely of a tiny embryo

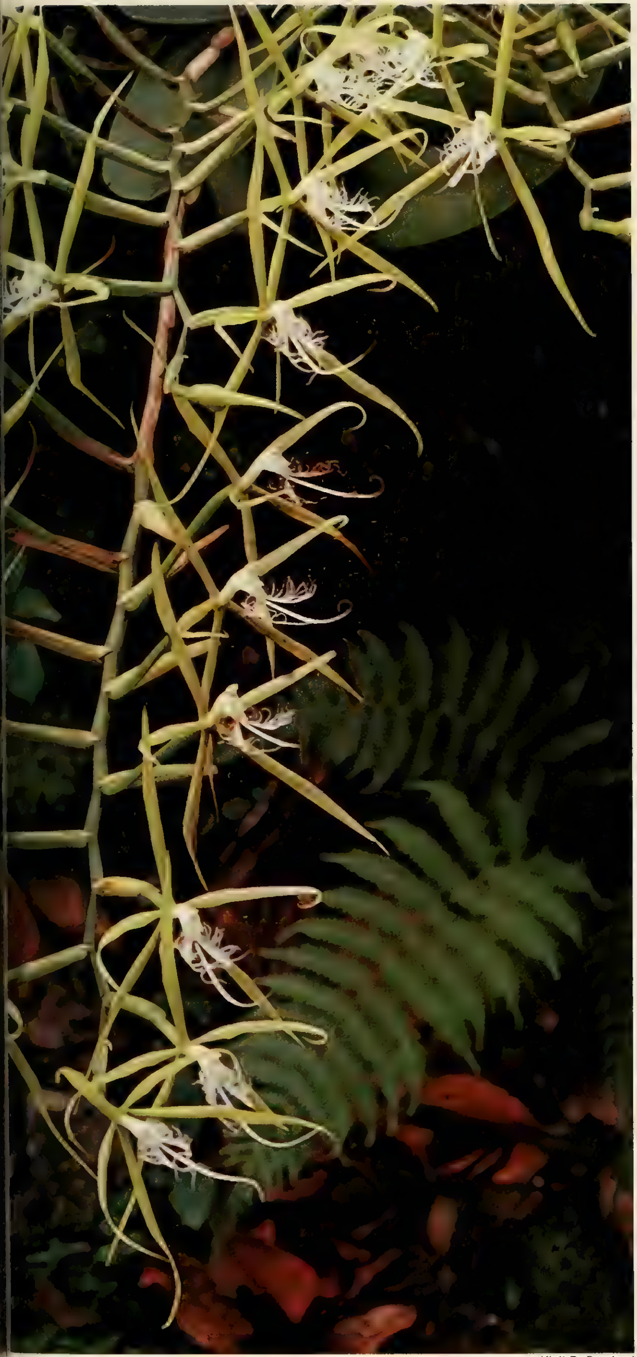


and a transparent testa only one cell thick. In the city or the wild, orchids do not need animal agents to spread seeds. Ripe capsules split open and the wind carries the seeds away.

I have found orchid plantlets citywide—on both rough-barked and lichen-covered trees. Seeds fortunate enough to reach the latter havens germinate in the presence of a species of fungus. Presumably, until the plantlets produce their first leaves and roots, the fungus nurtures the orchid, while the orchid's tissues offer a comfortable environment for the fungus.

Another factor contributing to the survival of orchids in the city is the apparent apathy of the general populace. More than 290 species of orchids have been described in El Salvador, and taxonomists believe that there are more than 300. Oddly enough, both urban and rural Salvadorans continue to think of orchids as the ornamental imports and florists' novelties that they are in North America. Orchids are not generally worn in El Salvador, and the middle class is only just beginning to discover their possibilities as house ornaments. Some species, such as the vanilla orchid, are thought to have medicinal properties, but these have remained mainly uninvestigated and unexploited.

The Salvadoran attitude toward orchids is reflected linguistically. The word *orquídea* is a technical term used by plant fanciers and botanists here. All tree-dwelling plants, including orchids, bromeliads, peperomias, ferns, certain cacti, mistletoe, and strangler figs, are known by the collective name of *parásita* or "parasite." Few Salvadoran orchids have common names, and those that do frequently share them with members



Kjell B. Sandved

The green-and-white flowers of Epidendrum ciliare, *abundant in Mexico and common throughout Central America as far south as Colombia, appear in El Salvador from April to June.*

of the same genus. For instance, *chorizo con huevo* is applied not only to *Oncidium cebolleta* but also to all yellow- and brown-flowered members of the genus *Oncidium*, of which there are fourteen. *Epidendrum pentotis* and *E. fragrans,* flowers of the city and of forests and coffee plantations, are known collectively as *conchitas,* or "little shells." *Catasetum integerrimum* and *C. russellianum* share the surprising name of *zapatellas suecas,* "little Swedish shoes." The shoe part of the name must refer to the slipper-shaped labellum, which is also found in the North American *Cypripediums,* but I have found no good explanation as to why they suggest Swedish clogs.

Since the flowers of the urban species are rarely larger than two or three centimeters and the plants are usually hidden by the dense foliage of their host trees, they are comparatively safe from dilettante collectors and gardeners. *Oncidium cebolleta* frequently grows on mango trees planted in the city to shade passersby. Green mangoes are popular sliced and served with salt and chili sauce, and the poor are adept at knocking the fruits down with sticks and stones. I have never seen anyone apply the same technique to orchids that grow out of reach.

The case of one urban species indicates that, for orchids, popularity is risky. As late as fifteen years ago, *Cattleya skinneri* (*flor de San Sebastian*) was a familiar sight in San Salvador, and books on the local flora note how common the flower was in the city. A comparatively recent burst of interest in what is now the national flower of Costa Rica has caused these extremely showy plants to vanish from their old haunts in public parks and in the city estates of the wealthy. The plants may still be found in San Salvador but their distribution can hardly be called natural. Now they brighten the enclosed private courtyards of middle-class homes, where they are stuffed into window boxes or wired to branches and logs.

Many questions about urban orchids remain unanswered. Why are some species seen on the outskirts of San Salvador but never seen downtown? Large and ancient fig trees mark important bus stops just outside the city limits. Here I found *Epidendrum stamfordianum, Isochilus,* and dense, matlike colonies of *Hexadesmias.* Are these merely remnant populations of a time when the area was a forest or are there subtle environmental factors that keep them around the periphery and deny them a niche in the city?

And as for the terrestrial orchids, will they be forever denied their old territory in the city? I have found one or two terrestrial species surviving in San Salvador. Last year I came across a mature *Cyrtopodium punctatum* growing in a bed of snake plants (*Sansevieria*) at the university. This orchid is the largest species in the country, bearing thick, rigid pseudobulbs more than three feet long. Because it was growing in an area that was originally a center for tropical research, this orchid may be the lone survivor of an earlier landscape. But there is no such explanation for the tight little colony of green-flowered *Habenaria alata* I found two months ago, growing in the center of a well-tended lawn. "Oh those," the owner said, "Aren't they cute? Just sprang up one day."

I suspect that orchids will continue to colonize San Salvador for as long as appropriate microhabitats remain and the interest of the residents remains tepid. Just recently I proudly dragged a girlfriend across town to see what I considered an especially fine stand of *Cattleya aurantiaca* growing on an African tulip tree off a side street. "How ugly," my friend sneered, "so small and only one color. Not at all like the ones I got for proms." ☐

A close view of an Epidendrum ciliare *blossom, seen from above, shows the lip pointing downward, as it does in most orchids. The ciliated side lobes probably entice hummingbirds and other pollinators.*

Kjell B. Sandved

hilean Flamingo Court and Dance

xt and photographs by Juan Muñoz

iese long-legged birds
st in muddy lakes where
and predator would need
airboat to reach them

The Tehuelche Indians of Argen-a's Patagonia region tell a legend out how the child-god Elal met th all the animals to give them ir places on earth. The flamingo, iich at that time was white, ar-ed late. It was assigned to a lake it had already been given to the an, so the flamingo had to go to arren, salty lagoon to live. Elal t sorry for the bird and decreed it henceforth its feathers should ve the color of the dawn sky.

A more recent explanation of the mingo's coloring is that it comes m carotenoids in the bird's food. any case, a brilliant pink mass of sting Chilean flamingos contrasts idly against the stark landscape the South American *altiplano*.

The Chilean flamingo, readily ntified by its bright red knees d feet, has the widest range and atest numbers of the American mingos. Its population, esti-ited at about half a million birds, ges south from Peru to Tierra Fuego, throughout Chile, Bo-ia, Argentina, Uruguay, Para-y, and southern Brazil.

In Patagonia, these flamingos ually nest in shallow, brackish oons, more than 11,000 feet ove sea level, which often dry up completely during periods of low rainfall. Temperatures range from 68°F in summer to −5°F or lower in winter. In the higher Andean lagoons, nighttime temperatures, even in summer, can suddenly drop below freezing, creating problems for feeding flamingos.

air of Chilean flamingos rform a mating dance. The ds pivot around their touching ls, gradually entwining their cks. After the dance, either rtner may still reject the other.

During the nesting seasons of 1971, 1972, and 1973, my wife and I observed and photographed an isolated breeding colony of Chilean flamingos near the village of Colán Conhué in western Chubut Province, Argentina.

The area is one of moderate relief, with elevations of from 2,400 to about 5,000 feet, and the nesting lagoon is about three-fifths of a mile wide and almost two miles long. The lagoon's usually exposed bottom is of a treacherous, quicksand type of mud that is highly caustic and encrusted with a layer of salt. Standing water is most often present only in the center of the basin. Amidst the mud, eight small, grass-covered islands serve as the actual nesting sites. These grassy knolls, situated above freshwater springs, form a long line 600 to 900 feet from the western shore. They average 90 to 240 feet in length and 33 to 50 feet in width. The flamingos feed at a number of shallow lakes three and a half miles from the lagoon.

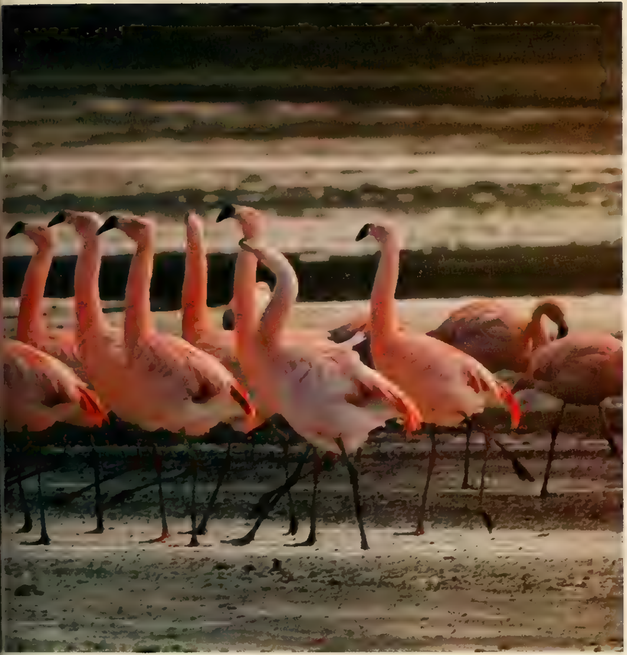
Probably no other flamingo nesting site in South America is so accessible to man and so close to his activities. A well-traveled highway passes within two and a half miles of the lagoon, and the ranch house of the Urretiviscaya family is only several hundred feet from the shore. José Urretiviscaya harvests salt from the lagoon during the nesting season but does not seem to disturb the birds. His livestock water at the same spring at which the flamingos feed and bathe.

Flamingos are noted for the irregularity of their breeding habits, often not returning to a site for several years. But here they bred each of the three years we observed them, and Urretiviscaya told us that during his forty years on the ranch he could not remember a year when the flamingos had not raised a crèche of young.

During the first few days of October, adult flamingos begin to arrive in the Colán Conhué area from their wintering grounds at lower elevations on the pampas and along both coasts of southern South America. This is early spring, when the temperature is above freezing for only a few hours each day. The flamingos scatter around their feeding lakes and appear to have very little interest in one another.

In 1973, the first flamingos arrived at the nesting lagoon on October 6, but spent their time feeding and sleeping in the central part of the lagoon. On the 7th, we counted twenty birds, and by the 13th, more than one hundred birds were sighted in the lagoon. There was some minor courtship displaying, one short-lived "march," or group dance, and for two hours they seemed to be doing an imitation of incubating eggs. Fifty or more birds sat on one island as if incubating, while a small group displayed beside them.

The flock increased daily by ten to twenty birds, and soon displaying continued for two or three hours at a time. Larger numbers were now arriving each day, and by November 2, we estimated that between 2,000 and 2,500 birds had arrived, and all of the eight nesting islands were occupied. On November 9, the colony numbered more than 4,000. Virtually all of the birds participated in courtship displays during these early days of Novem-



At the onset of a breeding season, displaying birds engage in a premating "group dance." The birds rush headlong for about fifty feet, do an about-face, then dash back to the starting point.

ber, and more than half started to build nests.

Displays of the Chilean flamingo take various forms but usually follow a distinct pattern. Typically, we observed a group of five or ten (usually led by a male) holding their heads in an "alert" posture with the neck stretched to its full length. They would then begin a "head-flagging" display, call to one another, and move their heads from side to side in a horizontal arc. This would increase in tempo during a period of several minutes. Others would soon join the head-flagging group, until there were twenty-five to fifty birds displaying together. At times the head flagging would stop as suddenly as it began, but more often it would be followed by "wing salutes" or a marching display.

In a march, the displaying flock rushes in a tightly packed mass for fifty feet or more in one direction while continually calling and head flagging. They then pivot in unison and dash back to their starting point. These marches are often repeated five or six times in quick succession. They stop abruptly, but the head flagging continues and then gradually decreases, as if the birds are winding down.

During periods of intense displaying, we observed many birds pairing. Two birds stand with their necks fully stretched, beaks touching. They then circle slowly, pivoting around the touching beaks,

Both male and female take turns sitting on the egg during the thirty-day incubation period. A change of shift often takes place at dawn, and the relieved partner flies off to feed at nearby lakes and streams.

hen the chicks are more than a eek old, they form a crèche, hich is patrolled by a few lults, or "aunties," that rve as herders and lookouts the absence of the parents.

adually intertwining their necks. t times there is some ritual peck- ig and sparring. This may continue r three or four minutes, after hich they walk off together if the ourtship is successful. During the arly period of copulation, the birds ften mount each other, especially hile bathing. Often a third will ount the second, and once we saw ur stacked on top of each other.

Frequent bathing and preening e important parts of the daily rou- ne during courtship. At the Colán onhué site, bathing is important ring the entire period the birds cupy the nesting islands because e caustic mud dries to cement rdness and must be removed hile it is damp. A nesting pair rou- nely spell each other for this pur- se.

Both sexes share in nest building. hey build cone-shaped, foot-high ounds by picking up mud in their lls and piling it up. Some of the ud is so soft that the birds drool it er the mound; the mud runs wn the sides and hardens. The g is deposited in a concave de- ession on the top of the mound, t some eggs are deposited on assy, level areas of the island. oth birds add to the nest until the y the egg hatches.

Late arrivals to the colony were ill displaying and mating through ovember 25, but the great major- of birds were incubating eggs. y December 8, almost the start of summer, the first eggs were beginning to hatch. On that day we counted 200 newly hatched chicks. Within a week, all but the infertile eggs had hatched on the island where nesting first took place. This synchronous pattern of egg hatching occurred, at intervals, on the other nesting islands in the lagoon.

uring a rainstorm, the parents turned from their feeding ounds to provide some shelter r their nearly full-grown young. fter the storm passed, the adults ft the young on their own again.

The thirty-day incubation period is the only time when the colony is relatively quiet. The birds sleep during the day, heads tucked under wings; occasionally they stand to turn the egg with their bills. At first light in the morning and just after sunset there is a change of shift. Birds that have fed in nearby lakes, ponds, and streams return to the nest, and a pair will usually spend a short time together. The new arrival stands over its incubating mate for a few moments before taking its turn on the nest. The other promptly leaves for the feeding grounds where, with the coarse filter in its bill, it strains the water for annelid worms, small mollusks, crustaceans, and such zooplankton as amphipods, copepods, and insect larvae.

A newly hatched chick has white down, red legs, and a red beak. After a few days, the down becomes gray; the legs and beak black. Feedings are several hours apart—a task shared, as is brooding, by both parents. The chick's head protrudes from under the brooding adult's wing, and with beaks touching, the feeding parent drools a red liquid into the open bill of the chick. This liquid is rich in fat and contains a good amount of glucose. Carotenoids, erythrocytes (blood cells), and about one percent whole blood are also parts of the mixture. The liquid is thought to be a secretion from the lining of the upper digestive tract.

The chicks leave the nest when they are three or four days old and able to walk. Searching for food, they mill around, scavenging eggshells, feathers, and mud from other nests. Crèches begin to form when there are from 100 to 200 week-old chicks. The assemblage quickly builds to hundreds of chicks, and they leave the nesting area en masse to wander all over the nesting lagoon. Frequently, the crèche will move to a freshwater spring where the chicks drink and bathe.

The crèches are supervised by only a few adults who serve as "aunties." These aunties may be parent birds who are staying with the crèche at a given time or, possibly, they are birds that have lost their egg or young. Another possibility is that they are unmated individuals or subadults that have a "parental urge" but no offspring. The ratio is approximately one supervising adult per one hundred chicks. The aunties function chiefly as herders and lookouts rather than actual protectors. They keep the crèche together by constantly patrolling the periphery, while a few maintain order among the inner ranks. As long as the crèche stays in the areas surrounded by sticky mud, there is little danger from foxes, dogs, or other mammalian predators. The chicks are seldom molested by predatory birds; they seem to have an instinct to draw tightly together when alarmed, doing so even if no supervising adults are nearby.

All of the eight nesting islands are completely abandoned by the time the youngest chicks from the last colony to hatch eggs have reached two weeks of age. By mid-January the mud around the islands dries up and no longer provides sanctuary for the birds. The entire crèche, now composed of chicks from all the nesting islands, moves to the middle of the lagoon where a few scattered springs and residual water keep the mud damp and impenetrable to predators.

The crèche, which in 1973 we estimated to be about 1,500 chicks, gathers around two constantly flowing springs on the eastern side of the lagoon to bathe, fight, and sleep under the watchful eyes of the aunties. From time to time a group of adults fly in, find their young (possibly by vocalization) and feed them. By the time the chicks are about fifty days old, their bills have developed enough so that they can begin feeding on their own. Some of the incoming adults relieve the aunties, giving them a chance to feed in the nearby lakes.

By late summer, the chicks are

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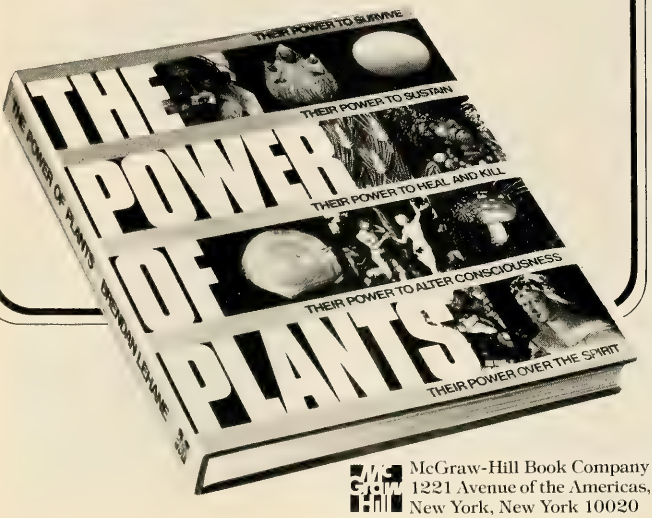
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ready to practice flying, and
group of young separates from th
main crèche. Strong winds are a
most constant in Chubut. Openin
their wings, the chicks run into th
wind to gain airspeed. Usually, thi
is enough to lift them two or thre
feet above the ground. Those ad
vanced enough to flap their wing
sometimes manage a fifty-foo
flight. Others come back down a
most immediately, hitting th
ground on the run. When severa
hundred birds are practicing, th
confusion is great, resulting i
many collisions between th
clumsy chicks. But they lear
quickly, and by the end of Marc
those with full plumage are begi
ning to fly to the nearest lake
around the nesting lagoons to fee

As their chicks become indepe
dent, the adults begin to leave fo
lower elevations in the north. Th
is a critical time for the young fo
by mid-April there are practical
no adults remaining. Those chick
unable to fly to the wintering are
are abandoned. Although they a
able to feed around the nestin
lagoon, very few can survive th
freezing rain and snow flurries
the hard fall and winter.

In our three years of observi
the colony, we estimated that th
population varied from 4,000
6,000 nesting birds, and the crèch
averaged about 1,500 young. Urr
tiviscaya said he had never se
any major changes in the popul
tion during the years he has liv
on the ranch. Unlike many oth
flamingo colonies, seasonal vari
tions in rainfall, which greatly
fect the shallow lagoons where t
birds feed and nest, apparently
not affect their breeding at this sit

The greatest danger to this c
ony is the accelerated developme
of Patagonia, bringing with it tou
ism, industry, and an expandi
human population. There ha
been numerous incidents of want
shooting of flamingos in the are
and with only nominal protecti
afforded the birds, this can only
crease. The local ranchers resp
the flamingos and do their best
protect them, but they cannot c
with the flood of settlers com
into the area. Our hope is that
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measures to create a proper p
serve that will secure the nest
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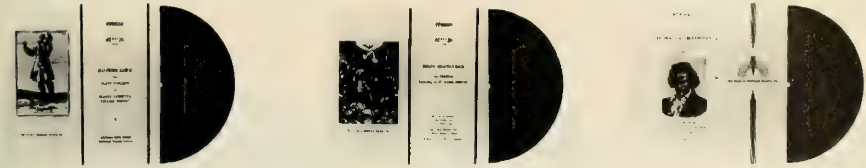

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The Wolf That Lost Its Genes

by James H. Shaw and Peter A. Jordan

Coyotes are "genetically swamping" this little-known carnivore, bringing it to the brink of extinction

Remnant populations of one of North America's most critically endangered mammals live within an hour's drive of Houston, Texas. Most travelers passing through the prairies and marshes along the upper Texas gulf coast would probably not suspect that a large carnivore, averaging some 55 pounds, still inhabits this farm and ranch country that has been settled for more than a century. Although the howl of the red wolf can still be heard from Galveston Bay to the southwest corner of Louisiana, perhaps fewer than one hundred animals, the last of their kind, still survive in the wild.

The red wolf (*Canis rufus*) once occurred throughout the southeastern United States from southern Florida to central Texas and possibly as far north as the Carolinas and Kentucky. Along with other large carnivores, red wolves were persecuted by generations of farmers and ranchers who feared for their livestock. State and local governments subsidized the destruction of the animals by offering bounties, and personnel of the Bureau of Biological Survey (forerunner of today's U.S. Fish and Wildlife Service) trapped and poisoned the animals under a mandate from Congress. These efforts, together with habitat alterations as the land was logged, grazed, and farmed, resulted in the animal's disappearance from most of its geographic range.

Just short of annihilation, the red wolf was officially recognized as an endangered species in 1965, and lethal control measures by federal agents were halted. Today, when

All photos by Russ Carmack, taken at Point Defiance Zoo, Tacoma, Washin rancher claims that wolves are ling his stock, a federal trapper dispatched to capture the sus- ct. Should the animal turn out to a red wolf, it is relegated to a tive breeding program.

Most endangered species can vive given adequate legal pro- tion and sufficiently large re- ves of critical habitat. The red lf is now protected by federal l state laws and there seems to enough suitable habitat to sus- n several populations. But a re subtle form of extinction eatens the species—genetic dilu- n through hybridization with other, far more numerous and ptable species, the coyote *nis latrans*). Although the nat- l occurrence of interspecies bridization is rare among free- ng mammals, human disturb- e of animal populations and ir habitats increases the chances his happening. The result can be alteration of the genetic charac- istics of one or both species.

As red wolf numbers declined, coyote (a species more resistant trapping and poisoning and ter suited to disturbed habitats) an extending its range eastward, nging the two into increasingly ater contact. Most members of genus *Canis* are interfertile; re being no physiological bar- rs against hybridization. Fur- rmore, the hybrid offspring may be fertile, either breeding ong themselves or backcrossing h either parent species.

Under normal conditions, differ- species of wild canids maintain etic distinctiveness through graphical separation or by mu- l intolerance in the form of terri- iality and species-specific court- p patterns. Evolutionists predict t hybridization is most likely to ur when a rapidly expanding species comes into contact with a less numerous close relative. Fluctuating populations and altered habitats also enhance the prospects for hybridization. Since all these conditions were present as coyotes invaded areas where red wolves were being drastically reduced, the behavioral safeguards failed and hybridization began.

The coyote-hybridization threat, together with very low red wolf numbers, requires that management be approached in terms of saving the red wolf's "gene pool." This term refers to the sum of genetic information carried by all members of a "deme," or interbreeding group. On a larger scale, it is all the genetic information possessed by a series of related demes that may make up the entire species.

Traditionally, wildlife management has largely been a numbers game, the objective being to either increase, decrease, or maintain population sizes with little or no regard for genetic changes. Management of a gene pool is broader because it considers not only numbers of individuals but also the amount of genetic variability preserved. When working with remnant populations, wildlife managers must try to save all remaining genetic variability in order to assure the species' adaptability to future environments. The smaller the remnant population's gene pool, the more vulnerable it is to dilution through interspecies hybridization. To preserve a gene pool, the species' genetic limits must be identified. For most mammalian and avian species this is no problem—the black bear, the whooping crane, and the white-tailed deer are so clearly distinct from their nearest relatives that there is no debate as to where one species ends and another begins.

Defining the red wolf's gene pool is difficult for several reasons. First, individual specimens range in size from that of large coyotes to that of small gray wolves (*Canis lupus*). Second, because so little is known of the red wolf's behavior, taxonomic comparisons by behavioral criteria have not been possible. And finally, the extent of the geographic overlap that once existed between the red wolf and the gray wolf in the eastern United States will never be known because both were long ago extirpated from that region and not enough skulls were preserved from either type to permit reconstruction of the original picture. So we will never know whether the red wolves of the south maintained themselves as a clearly distinct entity from the larger gray wolves to the north or whether the two merged into a continuum characteristic of single, widely distributed species. Most taxonomists describe the red wolf as a distinct species; some claim it is merely a small subspecies of gray wolf; still others suggest that it represents a stable hybrid complex between the coyote and the gray wolf.

Accurate recognition of a species and the limits of its gene pool have important conservation implications. The U.S. Fish and Wildlife Service, and other conservation agencies, recognize that an entire species on the brink of extinction presents a more critical situation than does an endangered subspecies in the same condition, provided that other subspecies exist safely elsewhere. Unless zoologists maintain a reasonable consensus on the question of separate-species status, agency administrators may face difficulty justifying significant portions of their limited budgets toward saving such animals as the red wolf. Most likely the issue will

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The Hidden Canyon
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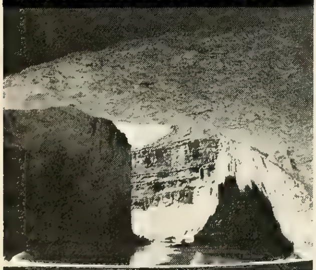

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never be completely resolved because of so much missing evidence, but we believe that the bulk of the evidence supports the separate-species view. Furthermore, for management purposes the animal should be given the benefit of any lingering doubts and recognized as a distinct species.

When we first became involved with the red wolf in 1970 its endangered status had been clearly established. The animal's ecology and behavior remained largely unknown, however, and the taxonomic uncertainty persisted. We began a detailed field study of the animal, concentrating on collecting ecological and behavioral data to aid management efforts and facilitate understanding of gene pool management. By comparing our results with those of similar studies on the gray wolf and the coyote, we also hoped to provide new insights on the taxonomic relationships between North American canid species.

We needed a study area that had a relatively high red wolf population density and that did not contain coyotes or hybrids. Because more than 90 percent of the remaining red wolf range is on private land, we also required landowner cooperation. A 1970 red wolf survey by the Texas Parks and Wildlife Department indicated that Chambers County, Texas, along the eastern shore of Galveston Bay, offered the best potential. Ranchers there proved cooperative, freely allowing us to trap, release, and track wolves on their land and sometimes recording useful observations. At the center of this area lies the Anahuac National Wildlife Refuge, which had already become a sort of center for red wolf research. Anahuac had kennels for holding wolves, and refuge manager Russel Clapper and his staff generously provided vital logistic support.

Elusive species can best be studied in the free-living state by the use of radio-location telemetry. The U.S. Fish and Wildlife Service loaned us radio telemetry equipment and supplied the services of Glynn Riley, a skilled trapper and self-taught biologist experienced in safe and effective live trapping of red wolves.

In the summer of 1971, Riley found unusually small canid tracks

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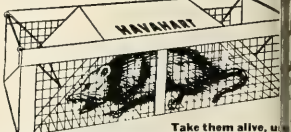

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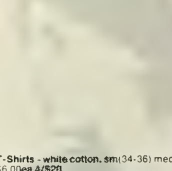

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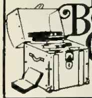

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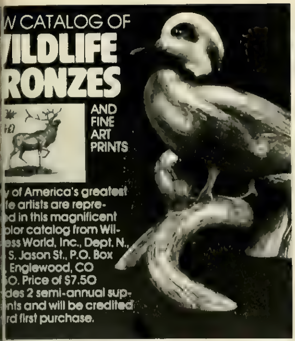

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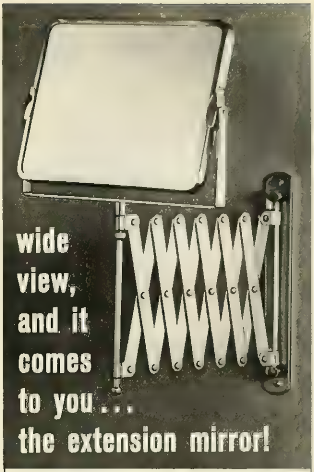
in the vicinity of the Anahuac refuge, indicating that at least one coyote or possible hybrid was living among the last red wolves. It was probably the same animal we captured the following November—a 36-pound adult female with a narrow, coyotelike head. We held her for five days while we searched the surrounding area for additional small tracks made in her absence. Fortunately, none appeared, so we concluded that she was probably the only abnormally small *Canis* in the study area. She was then immobilized, measured, photographed, and fitted with a radio transmitter collar. We released her at her capture point, hoping to learn whether or not such an atypical animal would be accepted socially by local red wolves.

The additional nine canids captured in the study area were markedly larger than coyotes and typical of red wolves before the coyote hybridization began. Four adults weighed from 52 to 76 pounds; five immatures, from 45 to 50 pounds, roughly 20 percent smaller than eastern gray wolves and nearly 100 percent larger than Texas coyotes. One young male became the only fatality when hunters found and shot the trapped animal.

Red wolf facial threat expressions proved to be unusually interesting. While all North American canids can threaten with a snarl, only the coyote is known to threaten with a wide gape of the mouth. Those animals that, on the basis of size, appearance, and capture location, were judged to be pure red wolves threatened only with a snarl and could not be induced to gape. Wild canids captured outside the study area and judged to be hybrids threatened with a gape. We believe the ability to gape is inherited rather than learned—a conclusion strongly supported by Benson Ginsburg's behavioral genetics studies on canids at the University of Connecticut. The threat expression may well be one of the more valuable criteria for distinguishing trapped red wolves from coyotes and hybrids.

To make genetic comparisons between species, subspecies, or local populations, population geneticists are relying increasingly upon comparisons of the molecular structure of enzymes. These struc-



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tural differences are simple and are direct reflections of genetic variations. Enzymes related to fundamental cellular processes, such as energy metabolism or respiration, tend to be less altered by environmental changes and are therefore conservative compared with many external characteristics, such as body size or color. Any observed differences in enzyme structure indicate that animals carrying them are members of demes that have been separated for quite some time.

We collected blood samples from our trapped animals and sent them to Robert Storez of Yale University who was studying enzyme relationships within canids. Storez isolated some thirty enzymes from the blood and examined differences in the molecular structure of each enzyme. He then compared our samples with others collected from known coyotes and gray wolves.

Only one of the thirty enzymes had more than a single molecular structure. Of its two forms, one was typical for the gray wolf and the other typical for the coyote, but neither form was 100 percent consistent within either species. This enzyme alone, therefore, could not invariably determine the species of an animal, but the frequency with which the two forms occur within given populations could be a useful measure of genetic changes through time and space. By this criteria, the animals in our study area ranked about midway between gray wolf and coyote populations. Outside the study area, populations suspected by other criteria of being hybrids proved virtually identical to coyote populations. This enzyme comparison could prove useful for monitoring populations that are suspected of undergoing hybridization.

Our main research effort was devoted to the ecology and behavior of free-living red wolves. Food habits, determined from the contents of scats, showed that these red wolves invariably killed animals smaller than themselves. Leading prey were nutria (a large aquatic rodent introduced from South America), swamp and cottontail rabbits, and cotton rats. Despite the numerous cattle and occasional deer in the study area, we found no remains of these larger animals in red wolf scats throughout the study's fifteen-month dura-

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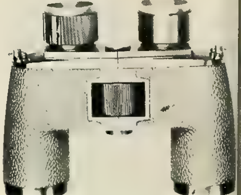

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tion. Sheep ranching is not practiced to any extent along the upper Texas gulf coast and this is fortunate because these animals might make easy and tempting prey for the red wolf.

Home ranges averaged only seventeen square miles for our radio-equipped red wolves, far smaller than gray wolf home ranges but similar to those of most coyotes. Red wolves proved to be primarily nocturnal, even in winter, an activity pattern more typical of coyotes than of gray wolves.

Within its remaining range, the red wolf forms small, unstable social groups, an arrangement well suited for hunting small prey. Gray wolves, in contrast, usually form packs that permit them to prey upon larger animals. Sightings of up to six or seven red wolves have been reported, but the vast majority of year-round observations are of one or two.

Parasites of serious consequence flourish in the warm, damp climate of the Texas gulf coast. Serious infestations of heartworms, hookworms, tapeworms, and sarcoptic mange have been found in cap-

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tured red wolves. A heavy heartworm infestation can kill adult red wolves just as it can kill domestic dogs. Hookworms constitute an even greater threat because they can be transmitted to pups, killing entire litters. Mange and tapeworm, although common, pose less of a threat in terms of direct mortality.

Since heartworms are mosquito-borne and hookworms are transmitted through contact with wet soil, we suspected that a positive correlation exists between rainfall and red wolf mortality. Residents of the study area recalled a sharp increase in red wolf numbers from 1961 to 1964. Local weather records showed that these were exceptionally dry years, particularly during the spring whelping periods. Although this is only circumstantial evidence, it suggests a causal relationship between rainfall, parasitism, and red wolf mortality. It also supports the view that the gulf coast region, while providing abundant natural foods for red wolves, is ecologically marginal because of the heavy parasite burden. These parasite loads were compensated for by some favorable conditions, such as the sparse human population and an abundant food supply from the highly productive prairies and marshes.

Overall we found that the ecology and social behavior of the red wolf within its remaining range were similar to those of the coyote and generally different from those of the gray wolf. These similarities between the red wolf and the coyote may explain why the behavioral barriers against hybridization between these species were breached. The gray wolf's strong social affinities cause that animal to form packs that maintain distinct territories and repel intruders, thereby minimizing opportunities for breeding with outsiders. Since neither the coyote nor the red wolf has such strong group bonds, hybridization is more likely to occur.

About five years ago the U.S. Fish and Wildlife Service began developing a recovery plan for the red wolf. Curtis Carley was assigned as biologist in charge of field operations and Russel Clapper was appointed leader of the Red Wolf Recovery Team. The recovery plan consists of three interrelated strat
gies: maintenance of a capti
breeding colony, reintroducti
into areas where red wolves on
occurred, and curbing hybridiz
tion within the animal's remaini
range.

A captive breeding colony h
been established at the Point D
fiance Zoo in Tacoma, Washingto
and field personnel of the Fish a
Wildlife Service have sent anima
considered to be pure red wolv
to Tacoma. Norm Winnick of t
Tacoma zoo reports that in 19
captive red wolves produced fo
litters totaling fourteen pups. Th
breeding colony could provi
long-term survival insurance if
else fails.

The captive breeding strateg
while a necessary last resort, h
several drawbacks. High costs a
limited space make it difficult
preserve a large enough gene po
A long-term captive population n
only loses many learned survi
traits but also may undergo *u-*
natural selection, losing criti
genetic information unrelated
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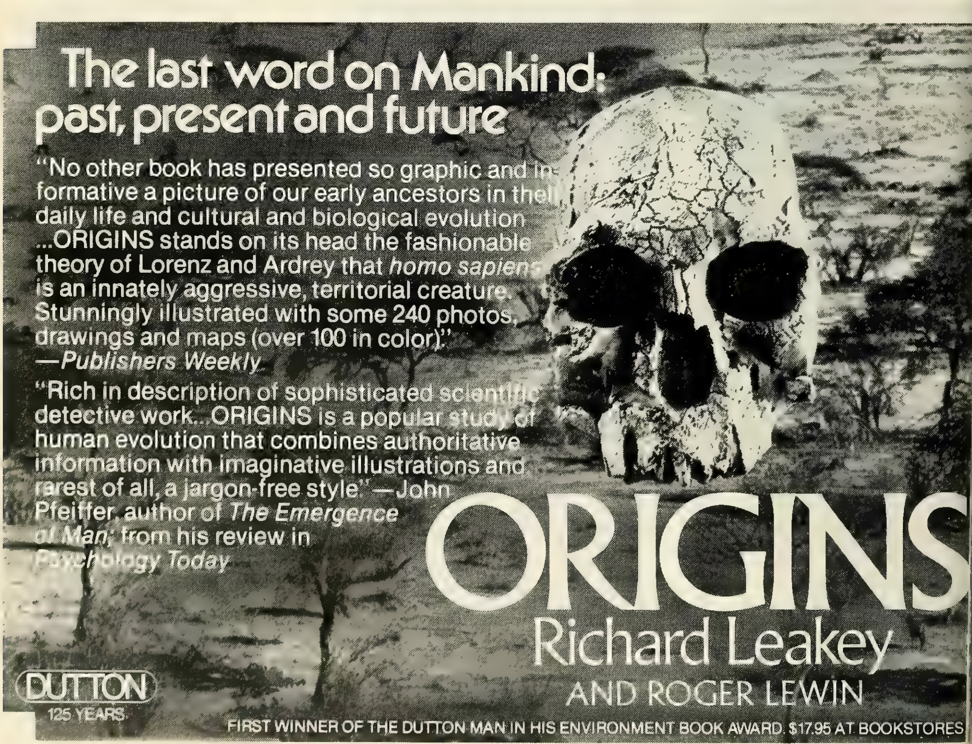
for survival in the wild. Saving



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cies only in a zoo is something a tie game with extinction. Only insuring that the red wolf can sist in the natural, free-living te can the species genuinely be served.

eestablishing red wolves someere within their original geophic range presents a difficult l critical challenge requiring se cooperation between federal l state wildlife agencies, private downers, and area residents, as ll as careful selection of suitable nsplant sites. Another problem olves the source of red wolves be transplanted. Captive-reared ividuals may not have the huntskills and wariness of humans essary to survive in a new enonment. Removing wild red lves from the gulf coast might y hasten the demise of the last wn wild population. The hylization threat will persist if coys are in the area, so sites seted for release cannot contain competitor, which has invaded st of the southeast in recent rs. Southern Florida and some nds along the Atlantic and gulf sts are essentially coyote-free l there may be other areas yet liscovered. The first transplant mpt did not provide a very enraging start.

ull Island lies about three miles the South Carolina coast. As t of the Cape Romain National dlife Refuge, it seemed a reaably good site for an experintal red wolf release. After eral years of planning, the Fish l Wildlife Service transported a r of wild-caught red wolves to ding pens on Bull Island. There y stayed for six weeks to acclite before being radio-collared released in December 1976. about a week the pair explored island; then the female sudly swam to the mainland and to be recaptured. (Later the e was also recaptured.) The h and Wildlife Service now bees that something frightened the mal and caused her to flee the nd. They are planning another troduction on Bull Island with ifferent pair of red wolves. But small size of the island, and its ximity to the mainland, may ke it difficult to hold such farging animals.

outhern Florida and perhaps a coastal islands may offer suitrelease sites. Everglades National Park has been suggested because protection would be automatic and no coyotes are known to occur there.

The third aspect of the red wolf recovery plan is the effort to maintain existing wild populations along the Texas and Louisiana coasts. During our 1970/1972 investigations, the wild red wolves seemed to be relatively homogeneous and robust, but even then we accounted for one apparent hybrid within the study area. Our radio tracking, incidentally, showed that this suspected hybrid regularly associated with a large male red wolf. After her death we examined her reproductive tract and found that she had been bred, presumably by her frequent companion. The Fish and Wildlife Service has since sampled wild canid populations more extensively, eastward into southwestern Louisiana. While some large, wolflike animals are being found, the ratio of apparent hybrids to red wolves seems to be increasing rapidly.

Curtis Carley now believes that there is little hope for preserving pure red wolves within the animal's remaining range. Accordingly, the Fish and Wildlife Service is now attempting to capture the last apparently pure red wolves for inclusion in the captive breeding colony. If the tide of the coyote invasion is overwhelming and the remaining red wolves are unable to maintain their genetic integrity, then this is the only course left open. It will, however, invariably hasten the rate at which the remaining wild red wolf population is genetically swamped by the coyote.

Whenever an animal population is drastically reduced, there is danger of irretrievable loss of genetic information. The possibility that some genes will be completely lost from the population by chance alone increases as the population shrinks. If only one corner of the species' original range is left, often the case with endangered species, losses from the gene pool through genetic drift will be permanent and will occur independently of natural selection. As more genes are lost, the population's chances of adapting to future environments diminish and the threat of extinction increases.

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When an entire population is lost, a large part of that species' gene pool vanishes. When the California grizzly became extinct in 1924, the differences between that bear and other grizzlies were lost forever. If grizzlies from the northern Rocky Mountains were introduced into California and allowed to thrive, they would not assume the particular set of traits that made the original California subspecies unique.

Transplanting members of one subspecies into the geographic range of another subspecies can result in genetic mixing that permanently blurs local distinctiveness. The bison that originally inhabited Yellowstone National Park were wood or mountain bison, a subspecies morphologically and behaviorally distinct from the more numerous plains bison. A few native mountain bison survived in Yellowstone into the twentieth century. In 1902 plains bison were introduced from herds in Montana and Texas to increase the Yellowstone population. The two subspecies interbred and, although bison thrive in Yellowstone today, they are a hybrid population, genetically different from their wild ancestors.

Some population geneticists, such as Michael Smith of the Savannah River Ecology Laboratory in South Carolina, have presented evidence suggesting that the ebbs and flows in a population's gene variability (heterozygosity) direc influence that population's grov rates and productivity. Not all thorities agree on this interpre tion, but if heterozygosity prov to play a significant role, it m someday provide important e mates of survival and recove potentials for endangered speci

Techniques for measuring netic variability in wild populatio are indirect and somewhat cru but they are undergoing rapid finement. Future wildlife manag can take advantage of new techn ogy to manage species more terms of their gene pools rat than in terms of numbers alone.

The only realistic hope for survival of red wolves in the w would seem to be transplantat into suitable sites outside of th current, shrinking range. We ho that the U.S. Fish and Wild Service and various cooperat agencies are successful in find coyote-free and otherwise s able sites within the generally r ognized former range of the wolves, and that the animals ad to these moves. If this does happen, this unique North Am can wolf will be known to fut generations as a mere vestige of former self, surviving only in z dedicated to preserving what mains of its genetic distincti ness.

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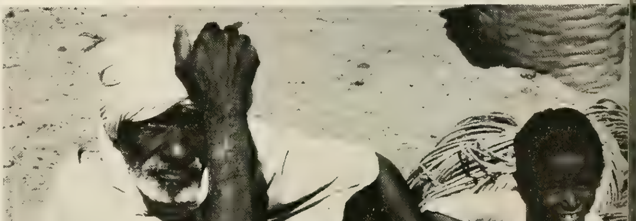

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Celestial Events

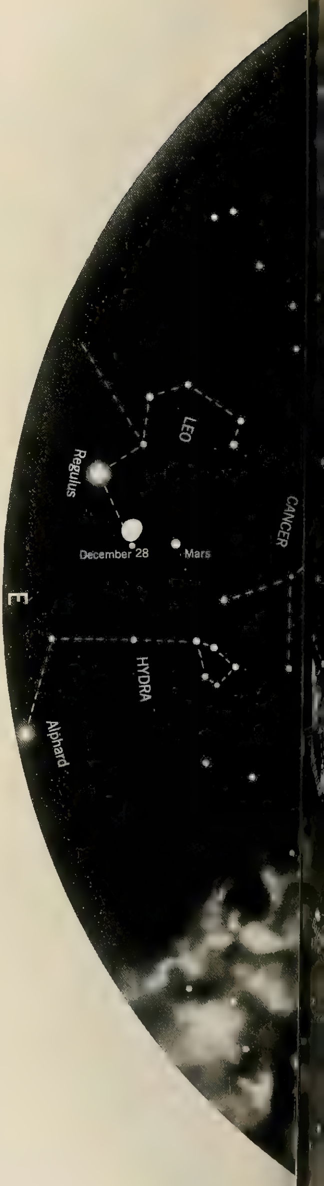
Thomas D. Nicholson

Sun and Moon: As December begins, the sun is moving east and drifting slowly south (relative to the equatorial plane) through the constellation Ophiuchus. On about the 18th, it crosses into Sagittarius, where, on the 21st, it arrives at the winter solstice, its most southerly position in the sky. This event marks a change in the seasons, from autumn to winter in the Northern Hemisphere.

The evening crescent moon should first appear in December on the 12th or 13th. As it waxes, it will brighten and stay in the sky later, until the night of Christmas Eve and Christmas morning, when it will be full. It will also be in conjunction with Jupiter that night, and the planet (the only bright object visible near the moon) will accompany the brilliant full moon on its high, long winter course through the skies, to give us an exceptionally beautiful Christmas Eve sky (weather permitting). Phases of the moon in December are last-quarter on the 3rd, new on the 10th, first-quarter on the 17th, full on the 25th. In early January, last-quarter is on the 2nd, new moon on the 8th, and first-quarter on the 15th.

Stars and Planets: With the coming of the winter constellations into our evening sky, we will find the brighter planets returning as evening stars.

Jupiter is the most prominent evening planet, brighter than any starlike object in our sky this month. It rises at about sundown in Gemini, and moves across the sky, about midway between Pollux and Castor (the twin stars of Gemini) and Aldebaran (the bright red star of Taurus), until it sets at sunrise. Mars rises some four hours after sunset, but earlier at month's end, as it rapidly approaches opposition in January. It will also brighten rapidly and should stand out prominently among the dim stars of Cancer, as it rises high into the south in the hours past midnight. Saturn rises late in the evening near Regulus, the bright star of Leo, and will be high in the south at dawn.



December 1–2: The waning gibbous moon passes near Mars and Saturn, visible from shortly before midnight on.

December 8: Latest sunset of the year occurs.

December 10: Perigee moon occurs. Its effects will enhance the normally strong spring tides tonight and tomorrow.

December 11–13: Mercury, Saturn, and Mars become stationary with respect to the stars and begin retrograde (westerly) movement. On the 13th, the Geminid meteor shower reaches maximum. Observers may see up to 50 meteors per hour early on the 14th, perhaps half as many on the 13th and 15th.

December 21: Winter begins at 6:24 P.M., EST. Mercury is at inferior conjunction and enters the morning sky.

December 22: The weak and unreliable Ursid meteors reach maximum. Jupiter is at opposition from the sun.

December 24: The moon is at apogee. Jupiter and the moon move across the sky together.

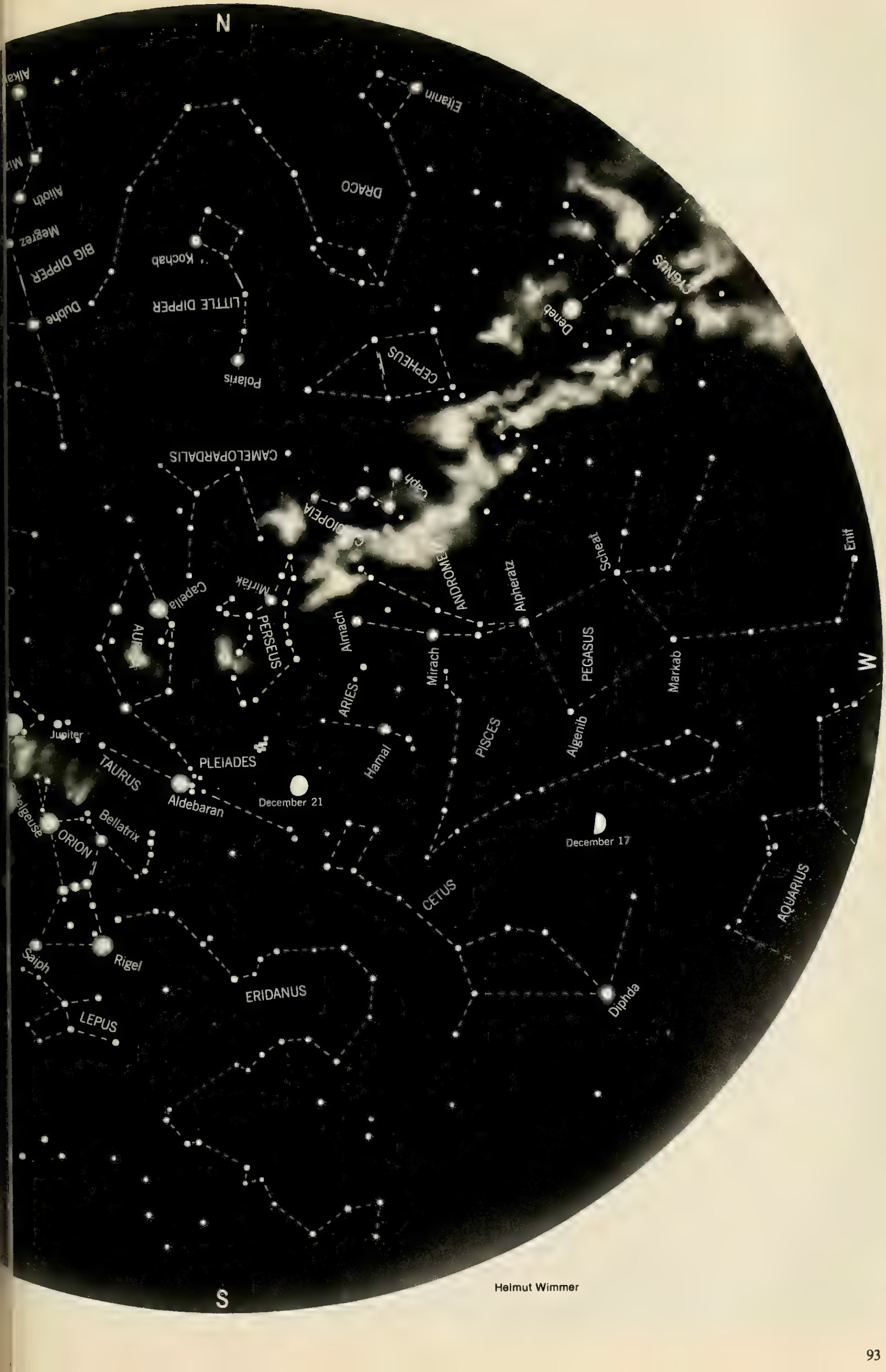
December 28–30: The moon passes near Mars and Saturn.

January 1: The earth is at perihelion, nearest the sun.

January 5: Latest sunrise of the year occurs.

January 8: The moon is at perigee.

★Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on December 1; 10:20 P.M. on December 15; 9:15 P.M. on December 31; and 8:15 P.M. on January 15; but it can also be used for an hour before and after those times.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Helmut Wimmer

A Christmastide Treat

This is the season to be merry and to eat the now plentiful chestnuts

In America, most of the time, nuts are not a problem. We can buy almonds and walnuts, filberts and cashews—shelled, even slivered and toasted and salted if we prefer. Macadamias are available for a price year-round and ready to munch, which is a boon, for their spherical shells resist most nutcrackers (I once had to resort to a claw hammer and a flat rock). But chestnuts are not normally plentiful in this country, except now, at Christmas time.

In New York City, chestnut vendors are out on street corners with their braziers. Gourmet shops have dusted off their chestnut-roasting pans hoping to sell some to those folks with wood-burning fireplaces at home. Food editors, meanwhile, dust off their favorite recipes for chestnut dishes. And so, with all this seasonal flurry of interest in the fruit of the genus *Castanea,* a nut-naïve person might conclude that chestnuts are a winter crop, shipped in for the holidays from California or Florida, like most other produce.

That, at any rate, was my working theory, until one spring I asked a petulant home economist (known behind her back as the Witch of Blender) why the American chestnut industry couldn't stock the stores after Epiphany. With scorn, the W. of B. retorted: "There are no local chestnuts. They're all imported."

How could this be? Chestnuts (*C. dentata*) grow wild on this continent. That's what the textbooks say. And as any schoolboy knows, Thomas Jefferson grafted cions of the larger, Old World chestnut (*C. sativa*) onto local host trees at Monticello in 1773. By 1803, Irénée Du Pont took time out from building the industrial empire that bears his name to start commercial production of European chestnuts in Wilmington, Delaware. All appears to have gone well for Du Pont's trees and their descendants. It was not for nothing that Henry Wadsworth Longfellow wrote, "Under the spreading chestnut tree/The village smithy stands," when he wanted to depict a typical scene of American small-town life. Chestnuts, like their cousins in the Fagaceae family, the oaks, were typical American shade trees. The tallest rose to a magnificent eminence of 100 feet. And when their nuts fell ripe to the ground, the spiny outer covering, the involucre, or bur, would open and release the delicious, starchy nut to anyone, man or foraging pig, who could deal with the thin shell.

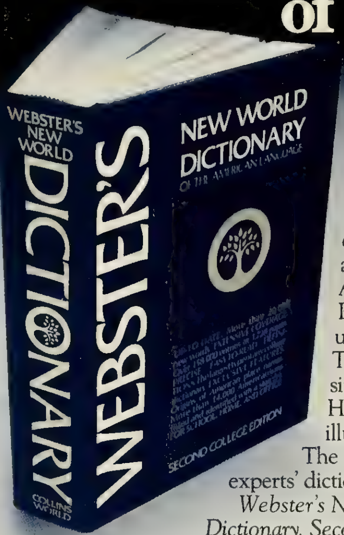
Around the globe, the story was similar. Corsican peasants led a life so bountiful in chestnuts that they used chestnut meats for flour in bread and porridge, in polenta, in fritters called *castagnacci,* in an anise-flavored cake known as *pislicine,* and as fodder for their pigs. So too, in the Aveyron and neighboring districts of south-cent
France, chestnuts were a stap
Koreans to this day consume che
nuts as we would eat potatoes.
the United States, however, the
of chestnut abundance came t
tragic close.

A tree grew in the Bronx. At
Botanical Garden. Or possibly
the Bronx Zoo. And it had beco
infected with a fungus broug
probably, from the Orient on n
sery stock. Within twenty ye
after the blight was discovered
1904, this fungus, *Endothia pa
sitica,* spread throughout the ent
American commercial chestnut
dustry, established itself in
cambium of virtually every prod
ing tree in the land, and gird
each one—and that was th
Spraying did not help.

Today, there is once again h
for a viable American chestr
The chestnut blight seems to h
finally been licked. A spontaneo
nonpathogenic strain of *E. par
tica* was isolated not long ago
Italy. And recent work by Rich
A. Jaynes, geneticist at the C
necticut Agricultural Experim
Station in New Haven, confi
that the new strain will convert
old, pathogenic strain out of
normally virulent state. By putt
the good fungus in proximity v
the old, Jaynes and his team of
researchers have, in effect, cu
sick trees. They discovered th
virus moves from the Italian vari
to the old Oriental fungus type
neutralizes the malignant tender
Jaynes doesn't know precisely h

by Raymond Sokolov

s happens or how to make it
read naturally without an assist
m human "vaccinators." Never-
less, the outlook for a revived
nerican chestnut crop has bright-
ed considerably.
But for the time being, until great
ciduous trees grow to maturity in
ir favored acid, sandy, well-
ined soil, chestnuts will con-
ue to come to us as a foreign
icacy. The most luxurious com-
rcial preparation is glazing. My
dlady in France once went
ough the arduous process of pre-
ving and glazing whole chest-
s in syrup to make *marrons*
cés, but she was a sturdy sort—
voman who singlehandedly de-
red her own daughter during the
ial bombardment of Caen in
4—and even she vowed never
bother with *marrons glacés*
in. The French—and Hungarian
hestnut industries also preserve
ole chestnuts as well as chestnut
ée. If you push the purée, which
lready sweetened and ready to
, through a potato ricer and top
ound of it with whipped cream,
have that elegant and very rich
sert known as Mont Blanc,
r the snowcapped Alp. Seekers
r the ultimate revel in this line
melt six ounces of semisweet
colate and blend it into the
stnut purée, along with a quar-
cup of dark rum, before ricing.
or many reasons—economic,
etic, and possibly political
ned purée is expensive, leaves
eeway for the cook with definite
s about sweetness levels, and



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cedes culinary craft and the option to add artificial ingredients to a foreign factory)—some people will want to start from scratch with chestnuts in the shell. This is not a simple matter. Expert opinion divides. The *Larousse Gastronomique* advises either (1) slotting the curved surfaces of the shells, placing them in a baking tin with a small amount of water, roasting in the oven for eight minutes, and peeling while still hot; or (2) slotting, deep-frying the chestnuts, a few at a time, for two minutes, and then peeling them as soon as possible after draining.

For her part, Marcella Hazan, author of *The Classic Italian Cookbook,* recommends slotting the shells all the way around the curved side, simmering in abundant water for twenty-five minutes (put the nuts into cold water and bring the water to the boil), then peeling one by one, leaving the other nuts in the hot water until you are ready to peel them. Finally, there is the utterly simple method of Lily Joss Reich (in *The Viennese Pastry Cookbook*), who does not slot the chestnuts at all. She simmers them in water for fifteen to twenty minutes, then extracts them one at a time and peels.

All these methods involve peeling the chestnuts while they are still quite hot. Slotted or not, the nuts become impossible to peel handily once they have cooled. The paperlike inner membrane loosens during heating but reattaches itself to the wrinkles of the nutmeat as it returns to room temperature. Slotting the nut is probably essential to prevent explosions in the oven or in hot fat. Slotting also eliminates many a burned finger since it speeds the peeling of very hot nuts no matter how they are heated. On the other hand, Mrs. Reich's procedure works perfectly well and does not require asbestos palms (the knack of partially cooling a handful of nuts to a manageable, but not too cool, temperature for successful peeling is quickly learned). Furthermore, unslotted nuts remain ideally dry and ready for ricing into flour for tortes.

Whatever method of peeling one chooses, prying loose two pounds of chestnuts from their fibrous husks is a paradigm of tedium. But it is the only way to acquire the fresh chestnuts for a corrupting and delectable array of chestnut dishes that run the gamut—quite literally—from soup to nuts. Perhaps the richest selection of nonsweet chestnut dishes in any ethnic menu comes from the Caucasus. In *The Best Foods of Russia,* Sonia Uvezian gives recipes for lamb soup with chestnuts, quince, and prunes (see below); quince stuffed with meat and chestnuts; and rice pilaf with lamb, dried fruits, and chestnuts.

Among less exotic cuisines, similar dishes also exist. Our own and other Western cookbooks all list some kind of fowl stuffing with chopped chestnuts as an ingredient. Hungary contributes a vegetable soup thickened with chestnut purée, heavy cream, and egg yolk. Braised chestnuts and unsweetened chestnut purée are traditional accompaniments for game nearly everywhere.

Most chestnut dishes, however, are desserts. Austria-Hungary carried chestnut baking to its highest level. Tortes, creams, sweet pâtés, and a sweet spectrum of other familiar chestnut goodies need no special introduction. France contributes an ice cream, a sort of chestnut rice pudding, cold and hot soufflés, dessert croquettes, and most elaborate of all, pastry barquettes filled with a purée of *marrons glacés,* flavored with kirsch, and iced with a kirsch fondant.

Marrons, incidentally, are a special variety of large chestnut that grow one to each bur. Typical Old World chestnuts (*châtaignes,* in French) come three to a bur. One way or the other, they are all chestnuts and, fancy or plain sized, don't need elaborate preparation. Scored and roasted over hot coals in a special pan or a wire basket and tossed frequently until tender, any chestnut will provide the perfect, convivial, and folkloric note to a holiday celebration. People without wood-burning fireplaces can use outdoor barbecues or even stovetop burners.

Aside from the obvious gustatory and spiritual benefits they bring, chestnuts will, according to German tradition, ward off backache if carried in one's pocket. An American variant of this nostrum promises relief from rheumatism. The English also have endorsed the preventive powers of chestnuts, but only those chestnuts that are begged or borrowed. And it is ir
portant to remember that ove
indulgence in chestnuts will,
legend, thicken the blood and cau
headaches. Keep this in mind wh
you are next pulling your chestnu
out of the fire. Don't try to pass
too many old chestnuts on yo
friends, either real ones or tho
hackneyed stories colloquia
known as "old chestnuts" in
American expression of unknov
etymology dating from about 188
Most important of all: stay aw
from horse chestnuts (*Aescul*
hippocastanum), those love
shade trees that bear nothing
real edibility and are, you mig
say, chestnuts of a different col

Lamb Soup with Chestnuts, Quince, and Prunes

1 pound boneless lean lamb, c
into 1-inch cubes
Salt and freshly ground bla
pepper to taste
3 tablespoons butter
1 medium onion, finely chopp
4 cups beef stock
1 medium potato, peeled a
cubed
1 small quince, peeled and
cubed
½ cup dried, pitted prunes o
cup fresh sour prunes
¼ pound chestnuts, shelled a
peeled
⅔ cup canned chick peas,
drained and rinsed
2 tablespoons clarified butte

1. Season the lamb with the
and pepper.
2. In a heavy pot, melt the 3 tab
spoons butter over moder
heat. Add the lamb and on
and sauté until browned, stirr
frequently.
3. Add the stock and season
taste with salt.
4. Cover and simmer 30 minut
Add the potato, quince, prun
and chestnuts. Cover and s
mer 20 minutes. Add the ch
peas and simmer, cover
about 15 minutes.
5. Taste the soup and make sur
is done. Before serving, s
the clarified butter into the so

Yield: 4 servings

Raymond Sokolov is a free-la
writer whose special field of in
est is the history and prepara
of food.

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two of us
& just
the two of
you...

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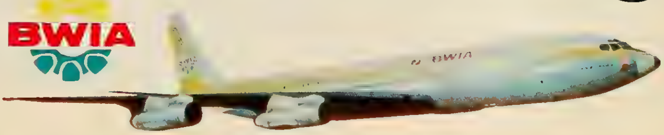


OPERATION DOUBLE
IN THE ROCKIES. (ALMOST

In most parts of the country, Operation Double Tree *is* working. Foresters are harvesting twice as much wood from commercial forestland.* And doing it without damaging the environment.

But in the vast areas that border the spine of the Great American West, the forests are not nearly as productive as they should be, given their true potential and the world's growing need for wood and wood fiber.

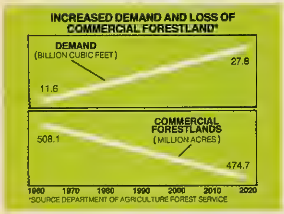
The problem is more one of *perception* than *potential*.

Some people have written the region off as unproductive—period. They see it as a vast wilderness, valued only for its wildlife, recreation and scenic beauty. These things *are* valuable. And large areas have already been set aside as permanent wilderness. But because wilderness areas have no roads, they are inaccessible to all but a few—and almost impossible to protect against wildfire and insects.

Operation Double Tree: Why it's needed and how it works.

In the U.S. alone, the demand for wood and paper products is expected to *double* in less than 50 years.

Yet today, only about one-third of this country's total forest is used to grow repeated crops of timber.



That works out to about one acre of trees for every man, woman and child. And each of those acres will have to be carefully managed to provide a lifetime supply of wood products.

Thus the reason behind Operation Double Tree—the forest industry's name for intensive forest management that can double the amount of wood grown on the nation's productive forestland. And do it in such a way that everyone can share in the multiple benefits of the forest.

The Under-Productive Forest.

The Rocky Mountain States contain 12.3% of U.S. commercial forestland, but they provide only 6.7% of the forest harvest—sort of an Operation Half-Tree, that could well place an unequal strain on other parts of the American forest.

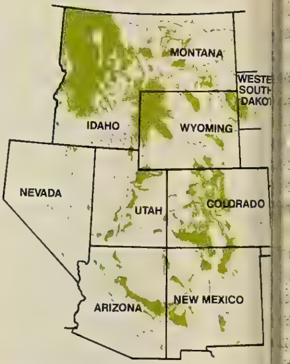
One of the reasons for this low productivity is the stagnated condition of the forests themselves—older trees, past their prime and more susceptible to disease and decay.

More intensive forest management would mean a healthier mix of young, thriving forests. It would also benefit other forest values, such as wildlife and watersheds. And open the forests so that more people could enjoy them.

These forests are only half as productive as they could be.

Unfortunately, the level of scientific forestry that could make all of these things possible simply hasn't materialized in the Rockies.

These ponderosa pines are shown here 56 percent of actual size. Both are about 75 years old. The smaller one grew in an overcrowded stand and, therefore, received less sunlight and water. The larger pine grew in an area that was thinned to give the best trees room to grow. Management made the difference.



The Rocky Mountain States contain 12.3% o
commercial forestland.

Now The Good News.

That's the bad news. The good
is this: What Operation Double Tr
doing in the rest of the country ha
ready begun in the Rockies, on a
scale.

Important first aid for the fo
comes from Potlatch Corporati
Idaho, where scientists are worki
develop odor-emitting pellets capa
repelling the destructive Douglas fir
beetle which, if left unchecked,
wipe out a fore
size of Rhode I
in a dec

TREE IS WORKING

In Libby, Montana, St. Regis Paper
pany helps make nature more pro-
ve by working within the natural
ystem. As the young forests grow,
are thinned out to give the best
more room to grow. And after the
est, the land is carefully prepared
he next generation—a new forest
netically improved seedlings that
grow stronger, faster.

St. Regis raises these seedlings in
wn greenhouses and nursery beds
bby. A similar program has taken
at Bonner and Plains, where Cham-
International has established its own
ling nurseries.

Operation Double Tree is not just
ing more trees, faster, but get-
nore use out of every
harvested.

In Wyoming,
dward
s

Lumber Company is using computers to analyze every log that comes into its mill to determine its best use.

Other companies like Champion, Potlatch, Kiabab, St. Regis and Southwest Forest Industries use virtually all of the wood in each and every tree they harvest. Residues from lumber and plywood manufacture, formerly considered waste, today are ground into wood chips for the paper mills.

A Long Way To Go.

So there is some progress with Operation Double Tree in the Rockies. And even more progress in forests all across the country. But we still have a long way to go.

On the average, industry lands grow 50 percent more wood than the lands owned by government and private individuals. Yet, even here, there's room for improvement.

Overall, the American forest is only half as productive as it could be. And this is a waste of one of our most valuable natural resources. But working together, all timber growers—private owners, industry and government—can learn to make the most productive use of our remaining commercial forests.

Forest management benefits wildlife, too.

Industry has invested millions to make the concept a reality. But money isn't enough.

Leaders and landowners alike must both understand the problem. And, more important, the solution.

For more information, write for our free booklet, "Managing the Great American Forest," American Forest Institute, P.O. Box 873, Springfield, VA 22150.

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Solar Magnetism

The sun's magnetic fields not only cause such solar phenomena as sunspots and coronal holes; they also affect the earth's atmosphere

The sun is quiet at present—it has been virtually without sunspots for the last few years of the sunspot minimum. I write these pages after looking through a telescope at an uninteresting sun that shows only two measly spots. Yet there is a feeling of expectancy—the existing sunspots already have the magnetic polarity of a new eleven-year cycle. Any day now the first great outbreak of the new sunspot cycle will occur, as it did in February 1956 and July 1966. The poles of the sun still show their coronal holes, which means that the general solar magnetic field of the last sunspot cycle will dominate until enough new-cycle spots erupt to change it in their mysterious way. So we watch the grand pattern of solar magnetism continue.

There are two kinds of solar magnetic fields: a relatively weak general field, which covers the entire sun, and local sunspot magnetic fields that are much smaller—about 50,000 kilometers (30,000 miles) across—but also much more intense. The general field, like that of the earth, has a positive (or north) magnetic polarity at one solar pole and a negative (or south) polarity at the other. Sunspot fields also have dual polarity. At great distances from the sun, the effects of sunspot fields of opposite polarity cancel, leaving the general field dominant. Locally, on the solar surface, the sunspot fields are far more intense than the general field. In fact, in the long run the sunspots are the source of the general field (*see* "The Turbulent Sun," November 1976 issue of *Natural Histor*

Sunspot magnetic fields seem form below the sun's surface in unknown way and then rise to t surface where they live for a fe weeks. Spots appear in pairs or groups of plus and minus polarit The groups often measure 50,0 km (about 30,000 miles) or mo across. At heights of about 10,0 km (6,000 miles) their magne fields are still almost as strong they are at the sun's surface. B the density of the gas falls off ve sharply above the surface, with t result that solar matter at the heights is dominated by the su spot magnetic fields and is align along them. Conversely, lower the atmosphere, in the photosphe (the visible surface), gas density much higher; and when the g has more energy than the field pushes the magnetic field arou The alignment of gas clouds j above the surface, easily visible hydrogen-alpha pictures, indica the direction of the local magne lines of force—imaginary li showing which way a comp would point.

As practically everyone kno the number of sunspots varies w an eleven-year period. Althou magnetic fields appear in pa they are not always symmet Sometimes one of the magne poles is broken up into a wea field and shows no spots. Th only a bright region called a pl marks the medium-strength fi Sometimes there are many spot each polarity, but there is alway balance of opposite fields. In e cycle the spots first show up higher latitudes, about 30° (har ever above 40°), but during course of the cycle, spots app in latitude belts gradually close the equator.

Emerging sunspot fields h

by Harold Zirin

characteristic appearance. The
t thing we see when a magnetic
d rises from below is a bright
ch in the chromosphere (seen in
red light of the hydrogen-α
ctrum line). Next come dark,
hed loops that trace the lines of
ce pushing up from below.
en the loops are particularly
ng, little sunspots appear at
h end. The material at the top of
loops is shifted toward the blue
ion of the spectrum, indicating
upward motion. Wherever such
ps intersect the sun's surface,
get a sunspot. It is thought
t sunspots are dark because the
ng magnetic fields inhibit the
ward flow of energy and leave
sunspots cooler and darker
n their surroundings. The sun-
ts spread rapidly as the feet of
arched loops rise through the
face, forming extensive regions
pposite magnetic polarity about
00 km apart. In time the sun-
ts break up and disappear, leav-
behind these magnetic fields in
eaker form. These fields mi-
e toward the poles of rotation
eventually form the weak gen-
solar magnetic field.
omehow, instead of dissipating
mixing and canceling with the
nants of other sunspot groups
where on the sun, the plus and
us polarities of a given field
to segregate into very large
ons of one polarity known as
olar regions. If the general
netic field of the sun has had
lus polarity in the northern
isphere, then almost all the
spot fields in that hemisphere
have plus polarity leading each
or group as the sun rotates
east to west and a minus
rity following. In the southern
isphere, the situation is re-
ed. As the unipolar regions
v, the minus polarity spreads to

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The River Congo
by
Peter Forbath

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the north pole of rotation, and the time of sunspot maximum, t new field cancels out the old ge eral solar field. Gradually the n magnetic polarity builds up at t north pole until, a few years b fore the sunspot minimum, a n general magnetic field is in pla at the pole of rotation, with mir magnetic field in the north, p in the south, and the leading s having the same magnetic sign the new polar field.

After eleven years, the sunsp have come and gone, and left b hind a reversed solar magne field. The process then beg anew, but with minus magne polarity at the north pole of ro tion and the leading sunspots in northern hemisphere now hav minus polarity. After twenty-t years we are back where started, with plus field at the no pole and minus field at the so pole.

The solar magnetic cycle is t a twenty-two-year cycle. Intere ingly enough, that is also the p odicity of droughts in the Gr Plains, which have occurred at alternate sunspot minima of 19 1954, and 1976, as well as earl Something in the earth's atn sphere is apparently connected w the polarity of the overall so magnetic field, rather than with number of sunspots (although oth much weaker effects in weather, such as abrupt change large-scale storm patterns, may connected with sunspot activity

The leading sunspot of a pai group always has the same m netic polarity as that of the gen solar field in that hemisphere. inexorable force seems to pro the spots to the proper polar Sometimes when a sunspot gr of the wrong magnetic pola rises to the sun's surface, the "r placed" sunspots muscle their into their proper place through surrounding magnetic fields, tw ing and straining the fields and p ducing many solar flares. greatest solar flares, such as th of August 1972, have been p duced in such reversed polarity gions.

We do not understand how twenty-two-year solar magn cycle is produced, but some g ideas have been set forth. In model the lines of magnetic f running through the inside of ın from pole to pole are wound up / the differential rotation of the ın. (The sun, being a sphere of gas ther than a solid body, is thought rotate faster at the equator than the poles: once every 26 days at e former; once every 29 days or ore at the latter, for an average tation period of 27 days.) As the agnetic field is wound up, ıotted lines of force appear, hich float to the surface as sunıot pairs. The winding up would ak first at higher latitudes, so the st spots appear there.

Another model carried this picre further and showed that old agnetic fields would diffuse outard from the old sunspot groups. cause of a tiny tilt of the arches their lines of force away from ıe east and west, the magnetic ld of the leading spot group oves equatorward, where it canls the fields from the other hemihere, while the field of the folwing spot drifts to the pole, ıere it produces the new polar ld.

These models make some sense t they have big problems. First, differential solar rotation winds the magnetic fields, the rotation ıst itself slow down. Actually, presence of differential rotan is somewhat doubtful. Sunots and some measurements of photosphere show differential tation, but large-scale surface ıgnetic patterns do not. Nor is magnetic field seen to diffuse tward from the active solar rens. In fact, our magnetic obsertions of the surface are too crude show the long-term poleward fusion of magnetic fields or the ncellation of the polar field, so can't be sure that this model valid.

One of the most interesting ets of solar magnetism is the exence of coronal holes. A long ıe ago it was noticed that, alough the outer atmosphere, or rona, could be seen during total ipses as a pearly halo around sun, it sometimes had missing ches. At sunspot minimum the ona was absent at the poles, ile at sunspot maximum it was ible all around the edge of the ı. When X-ray pictures of the ı became available, we could see corona against the solar disk hout an eclipse. Although the k is far brighter in ordinary

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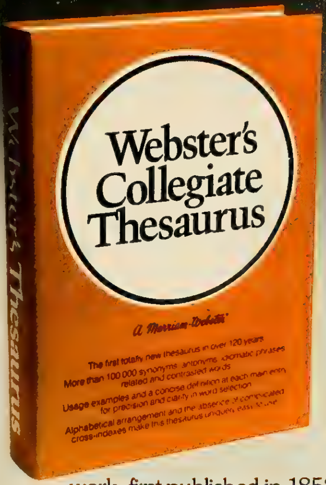
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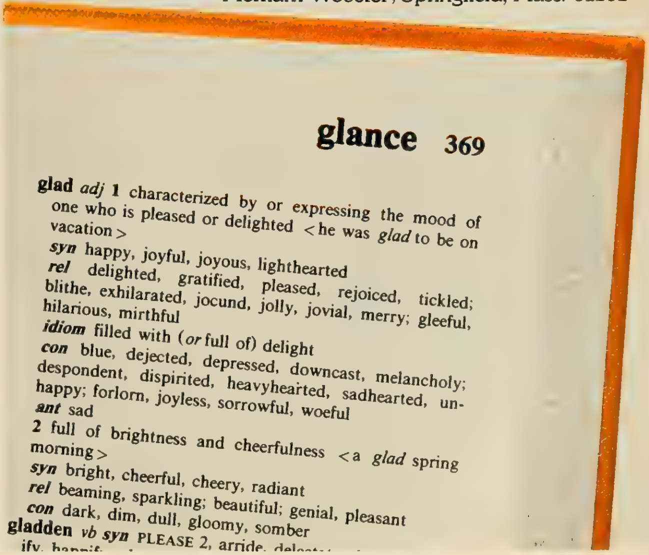

glance 369

glad *adj* **1** characterized by or expressing the mood of one who is pleased or delighted <he was *glad* to be on vacation>

syn happy, joyful, joyous, lighthearted

rel delighted, gratified, pleased, rejoiced, tickled; blithe, exhilarated, jocund, jolly, jovial, merry; gleeful, hilarious, mirthful

idiom filled with (*or* full of) delight

con blue, dejected, depressed, downcast, melancholy; despondent, dispirited, heavyhearted, sadhearted, unhappy; forlorn, joyless, sorrowful, woeful

ant sad

2 full of brightness and cheerfulness <a *glad* spring morning>

syn bright, cheerful, cheery, radiant

rel beaming, sparkling; beautiful; genial, pleasant

con dark, dim, dull, gloomy, somber

gladden *vb* ***syn*** PLEASE 2, arride, delect...
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light, the corona's million degree temperature makes it a potent source of X-rays. Long-term X-ray observations of coronal holes have enabled us to watch their evolution.

It has been found that coronal holes occur wherever magnetic field lines stretch far outward from the solar surface and are swept away by the solar wind, so that they do not return directly to another point on the sun. These "open" field lines permit hot coronal material to escape into space as high-speed streams in the solar wind. Because the general field, which dominates at sunspot minimum, is simple and open at the poles, we get polar coronal holes.

Besides the polar holes, several extensive equatorial coronal holes were observed in X-rays by Skylab. In each case the hole followed a large-scale magnetic pattern—sometimes extending north–south nearly from pole to pole—in which the magnetic field flowed out into interplanetary space. Studies of the solar wind and geomagnetism showed that a series of high-speed interplanetary streams accompanied by geomagnetic disturbances was associated with these coronal holes. These disturbances showed up every twenty-seven days, each time the hole rotated with the sun to face the earth.

Geomagnetic storms always occur during the last few years of the sunspot-cycle maximum and into the minimum, as though, with the sunspots gone, the solar magnetic field is getting itself reorganized and simplified for the next cycle and forming extensive coronal holes in the process. Unfortunately our instruments are not good enough to pick out all these large-scale magnetic patterns, but the coronal holes trace their locations for us. The patterns are so extensive and long lasting that they are enabling us to test whether the sun does in fact rotate faster at the equator than at the poles.

The largest coronal hole observed by Skylab lasted seven rotations, or 189 days, and stretched from the north pole to forty degrees south latitude. If the sun really rotates 10 percent faster at the equator than at the poles, as indicated by some measurements, we would expect to have seen the coronal hole wrap nearly once arou
the sun in this period—instead, t
equatorial part gained only twen
degrees. This indicates either th
there is no differential rotation
that the large-scale magnetic fiel
are unaffected by it and flc
around the solar surface like con
nental plates.

The equatorial coronal holes a
usually low-latitude extensions
the polar holes. It has been su
gested that the sun's magne
field is like the two stitched halv
of a baseball, at least for part
the cycle, with the north field d
tributed around the surface in t
longitude sectors and the sou
field protruding upward in b
tween. It is further suggested th
these field patterns are blown
ward the earth by the solar wind
that as the sun rotates, the ea
passes from one solar polarity
the other within a few hours.

It has been found that whene
the interplanetary magnetic fi
blowing from the sun has a co
ponent that is parallel to t
earth's magnetic field and then
verses its polarity (which may ha
pen as the "baseball stitche
sweep across the earth), gr
changes are brought about in
outer reaches of the earth's fie
Geomagnetic substorms take pla
at such times, accompanied
auroras, other atmospheric effec
and even power outages. This m
be a clue to the way in which
polarity, and not just the mag
tude, of the solar magnetic field c
play a role in geomagnetic distu
ances. The sun's magnetic fi
returns to the same sign ev
twenty-two years even though
magnitude of the field peaks ev
eleven years.

For a long time we have be
puzzled by the fact that only cyc
of twenty-two years can be fou
in the terrestrial climate in su
phenomena as the twenty-two-y
Great Plains droughts and in te
perature-sensitive isotope ratios
tree rings. The key to the puz
of some of the earth's chang
climatic rhythms may thus lie in
solar magnetic cycle.

Harold Zirin teaches astrophys
at the California Institute
Technology in Pasadena and r
the Big Bear Solar Observat
one of the Hale Observatories.

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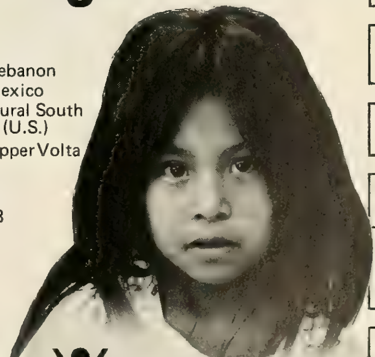

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The Elusive Marsh Birds

RAILS OF THE WORLD, by S. Dillon Ripley, with 41 paintings by J. Fenwick Lansdowne. *David R. Godine, Publisher, $75.00; 406 pp.*

The tradition of the lavish and costly treatise dealing with a single family of birds is more than a century old. It first flourished during the latter half of the nineteenth century, when—for the edification and delight of wealthy "subscribers"—ornithologists, artists, and publishers vied in producing large and handsome volumes, with hand-colored plates, in strictly limited editions. Many of these monographs have soared in value in recent years, thanks to the general affluence that brings more and more collectors into the market, and to the less savory demands of the "breakers," those art dealers who bid against the bibliophiles with the intent of retailing the color plates, page by page. In recent catalogs we have seen D.G. Elliott's monograph on the hornbills quoted at $2,450; Wyatt and Sharpe's swallows at $3,150; and Gould's toucans at $3,750. And some run much higher.

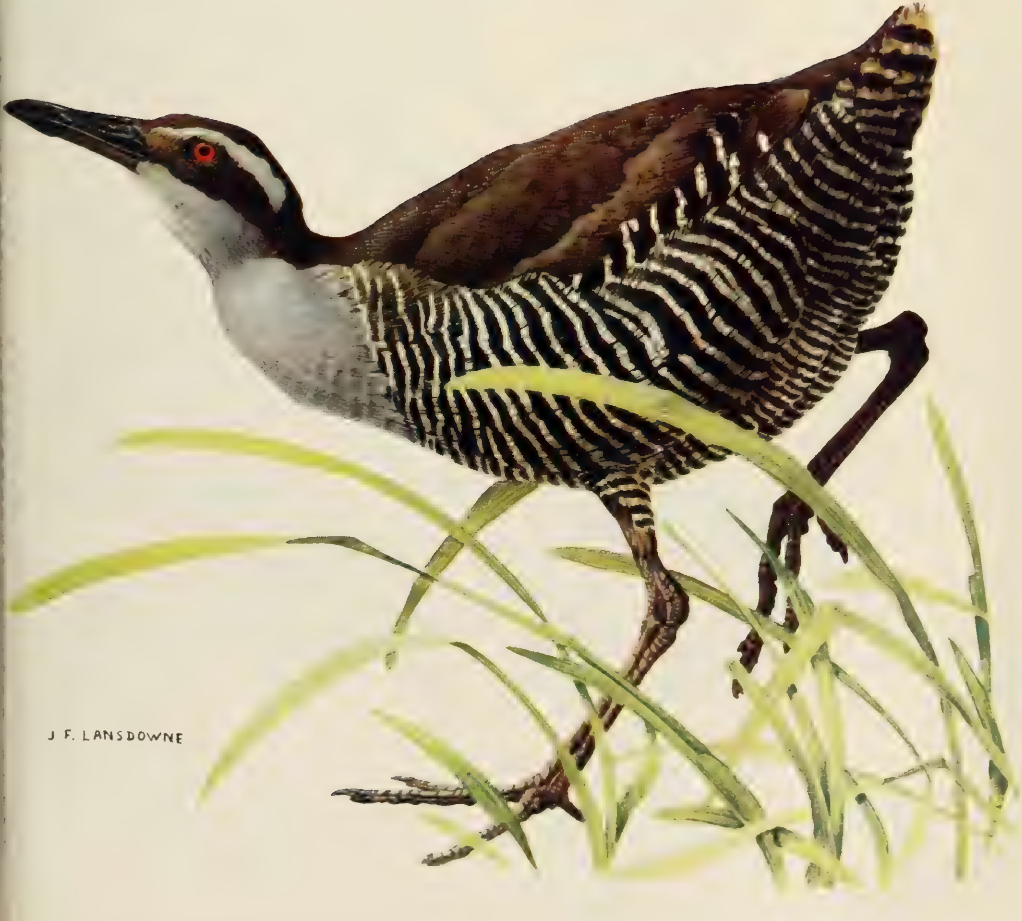
Because of recent tremendous strides in color reproduction, the days of the hand-colored plates are over, but today there is no shortage of serious ornithologists devoting themselves to single avian families, with fine artists to supply the portraiture. Such a book is Ripley's *Rails of the World.*

There are, of course, a few basic requirements for the creation of a successful monograph. First, there is the family itself. It must be interesting and varied, and the rails are that. Secretive and elusive, inhabitants of swamps, marshes, bogs, and deep forests where they can quickly conceal themselves, many of them are still mysteries to us. This is a family a number of whose members are now threatened, endangered, or recently extinct, and almost the entire family is vulnerable, as the wetlands of the world are drained and filled. And as Ripley says, "What a paradox; to fly poorly, to occur so widely, and to evolve flightlessness so easily!" A fascinating family indeed.

Other requirements would seem to include a dedicated scientist willing to spend years of research in field and study on a single-minded quest; additional months of effort and no little talent on the part of an artist; and finally, a publisher willing to give time, capital, and tender loving care to every detail of the final product.

All these elements are happily combined in this beautiful book. S. Dillon Ripley, already a noted ornithologist and author, and present the innovative directo the Smithsonian Institution, brought the broad scholarship the true Renaissance man to splendid work. J. Fenwick La downe, one of today's leading artists, has painted the portr with his usual accuracy and fa fulness to detail; their reproduc on the pages of this royal qu volume in a multicolor proces striking.

In plan, the book is stand Brief chapters (but in this case ticulate and spiced with literary historical allusions) dwell on rail family: its distribution, history, habits, and voice. By p 33 we are into the species tr ments, which vary in length, pending on current knowledge. clapper rail, for example, is tre to two color plates, one map, a to races, and 2,000 words of t Its races occupy another se pages. Mayr's chestnut rail, or other hand, receives the follo treatment, quoted in its enti "Mayr's Chestnut Rail [of Guinea] is a mountain forest cies about which very littl known." Except for the " knowns," the species treatm are under the headings of sy omy, other names, descrip measurements, distribution, st by Robert Arbib

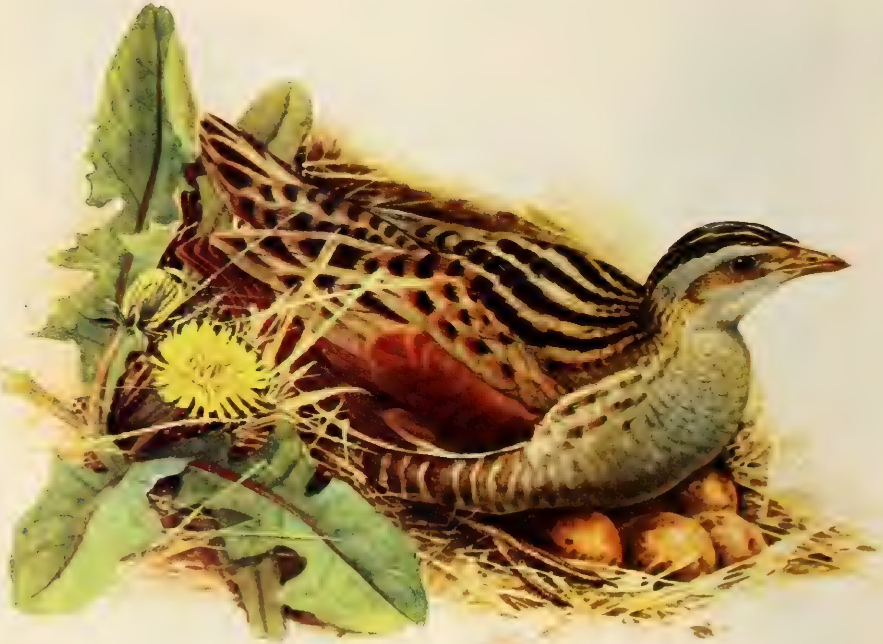

J F. LANSDOWNE

and remarks. Ripley is a "lumper": he has reduced the number of genera to 18, and of species to 129, of which 6 are definitely extinct and 2 probably so. Birders will note that the king rail is demoted to subspecific rank (of the clapper). Minus one for the life list! Without getting into a taxonomic discussion here, I have one minor quibble. I dislike the elision of modifiers into single words: whitewinged coot, rustyflanked crake, graynecked wood rail should be joined with marital hyphens, not merged into illicit cohabitation. An extensive bibliography at the end of the work brings the literature through 1974.

An important and valuable addition to the monograph is Storrs L. Olson's synopsis of the fossil rails. Because many of these rails inhabit swamps and bogs, a rather rich fossil avifauna has been discovered. His treatment, with many photographs, covers 38 species and lists 20 more, some as yet undescribed. Included is a lengthy discussion of the mysterious *Aphanapteryx bonasia,* the Mauritius hen. Most fossils date from the last 500 years, although the family traces back at least to the lower Eocene.

Finally, it should be said that this book, produced in Italy, is truly a tactile and visual pleasure. Its fine paper, its elegant typography, its rich color printing, artistic format, and binding—every detail gives evidence of painstaking devotion to the best in book production toda there is almost a sensual pleasu in turning the pages. At $75 t price seems high, but the standa edition is only 4,600 copies, so t publisher is taking considerab risk. But win or lose, all concern with the creation of this exempla monograph are to be thanked a congratulated.

Robert Arbib writes for the N tional Audubon Society and al edits their bimonthly magazi American Birds. *His book,* T Lord's Woods, *won the John Bu roughs medal as the outstandi nature book of 1972.*



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Additional Reading

Nymphs of Nantucket (p. 10)

The first report on Nantucket's human babesiosis problem, "Babesiosis in a Massachusetts Resort," by K. A. Western et al., appeared in the *New England Journal of Medicine,* vol. 283 (1970), pp. 854–56. Since then, literature on this subject has appeared in other scientific journals. For example, A. Spielman, in "Human Babesiosis on Nantucket Island: Transmission by Nymphal *Ixodes* Ticks," *American Journal of Tropical Medicine and Hygiene,* vol. 25 (1976), pp. 784–81, demonstrated that ticks transmit the disease in one stage of their development after having been infected in a different stage. An ecological study of the island to determine which animals are involved in transmitting the disease has been reported by G. R. Healy et al. in *Science,* vol. 192 (1976), pp. 479–80 ("Human Babesiosis: Reservoir of Infection on Nantucket Island"). The most recent article is "Human Babesiosis on Nantucket Island," by T. K. Ruebush et al., in *Annals of Internal Medicine,* vol. 86 (1977), pp. 6–9.

Madagascar (p. 26)

Virginia Thompson and Richard Adloff have collaborated on a number of books about former French colonies; one of them, *The Malagasy Republic: Madagascar Today* (Stanford: Stanford University Press, 1965, $15.00), is the first encyclopedic survey in English to describe the political, economic, and cultural developments on Madagascar since the end of World War II. It does so with text, photographs, a glossary, an index, and a bibliography.

Placing the Dead: Tombs, Ancestral Villages, and Kinship Organization in Madagascar, by Maurice Bloch (London: Seminar Press, 1971), is based on the author's fieldwork with 5,000 Merina people in Imerina, a mountainous region in the heart of Madagascar. Emphasized in this monograph is his characterization of Merina society as "extremely diverse," in which ties with ancestral villages and habits are balanced against the practicalities of everyday life.

Eucalyptus Bark (p. 36)

In *The Biology of Eucalypts,* Studies in Biology Series No. 61 (New York: Crane, Russak & Co., 1976), L. D. Pryor discusses bark in relation to the other parts of the tree. A general treatment of the eucalyptus is included in *Trees of the Australian Bush,* by E. Worrell and L. Sourry (Melbourne: Angus and Robertson, Ltd., 1967). *The Eucalypts,* by A. R. Penfold and J. L. Willis, in the series entitled World Crop Books, edited by Nicholas Polunin (New York: Interscience Publishers, 1961), focuses on eucalyptus forestry.

Faeroe Islands (p. 40)

The Atlantic Islands: A Study of the Faeroe Life and Scene (London: Routledge and Kegan Paul, Ltd., 1970, $13.25) was written by Kenneth Williamson, a naturalist whose familiarity with the islands is such that he is able to give us lists of mammals and birds, discuss local customs at length, draw and explain the use of Faeroese tools and farm buildings, and provide a glossary of Faeroese words and place names, as well as an extensive bibliography.

Two books by Hedin Bronner, *Three Faroese Novelists: Jorgen Frantz Jacobsen, Hedin Bru, and William Heinsen* (New York: Twayne, 1973) and *Faroese Short Stories* (New York: Twayne, 1972) reflect the literary world's interest in the Faeroe Islands. These books trace the history of Faeroese literature and give the reader a sample of works translated into English. Bronner's works include bibliographies and are useful for providing a quick historical sketch of the Faeroes. A new journal, *The Faroe Review,* is the only English-language periodical that deals solely with the Faeroe Islands. It is obtainable from the editor, E. Thomsen, P. O. Box 160, Tórshavn, Faeroe Islands, for $2.50 per copy.

China's Mariners (p. 48)

Children of the Yellow Earth: Studies in Prehistoric China, by Johan Gunnar Andersson (Cambridge: MIT Press, 1973, $4.95 in paperback), provides an interesting background for the study of prehistoric China. Translated from Swedish by Dr. E. Classen, it was originally published in 1934. More recent is Kwang-Chih Chang's *Archaeology of Ancient China* (New Haven: Yale University Press, 1971, $6.95 in paper). In *The Southern Expansion of the Chinese People* (New York: Praeger Publications, 1972), C. P. Fitzgerald follows the flow of Chinese presence and influence to the south, both by sea and by land, in historic times. C. G. Simkin, who served as an economic consultant in Asia and became interested in the history of trade in that part of the world, has written *The Traditional Trade of Asia* (London: Oxford University Press, 1968, $10.50). Intended for the general reader, the book contains maps, a chronological chart, photographs, and bibliography. An all-inclusive work is the 3-volume *An Ancient Economic History,* by Fritz M. Heichelheim (Leiden: A. W. Sijthoff's Uitgeversmaatscha
pij, 1958–1970). These massive tome
available to the reader through inte
library loan or in larger libraries, su
marize our knowledge of early worl
wide trade. Finally, for a Western vie
point of Chinese trade, the journals
the early discoverers of Asia, from Pli
to Marco Polo and beyond to nin
teenth-century imperialists, are e
cerpted in *Silks, Spices, and Empire,*
Owen and Eleanor Lattimore (Ne
York: Dell Publishing Co., $.95
paperback).

The question of early Chinese a
other Old World contacts with the Ne
World is addressed by chapters in v
ume four of the *Handbook of Midd*
American Indians, edited by Gordon
Ekholm and Gordon R. Willey (Aust
University of Texas Press, 1966). "T
Problem of Transpacific Influences
Mesoamerica," by Robert Hei
Geldern (pp. 277–95), and "The Role
Transpacific Contacts in the Develo
ment of the New World Pre-Columbi
Civilizations," by Philip Phillips (p
296–315), provide two somewhat co
trasting viewpoints. A more recent c
lection of papers on the same subject
Man Across the Sea: Problems of P
Columbian Contacts (Austin: Univ
sity of Texas Press, 1971, $13.9
edited by Carroll L. Riley et al. G.
Worcester's *Junks and Sampans of t*
Yangtze (Annapolis: Naval Instit
Press, 1971) contains illustrations
modern Chinese vessels that wo
provide some idea of how a seago
junk looked.

Orchids (p. 64)

Fritz Hamer's two-volume *Las*
quídeas de El Salvador (San Salvad
Ministerio de Educación, 1974, $40.0
the first complete work on the Orch
aceae of this country, describes
species in Spanish, English, and G
man. Each species has its own illus
tion; many are in color. Fourteen ad
tional species have been found in
Salvador since the publication of th
volumes. Edward Ayensu's "Beaut
Gamblers of the Biosphere" in
October 1974 issue of *Natural Hist*
(pp. 35–45) discusses the dispersal
the orchid family throughout the wo
Calaway H. Dodson's "Co-evolutio
Orchids and Bees" appears in
evolution of Animals and Plants, edi
by Lawrence E. Gilbert and Peter
Raven (Austin: University of Te
Press, 1975), and relates male bee
orchids and the scents they prod

Flamingos (p. 72)

Leslie Brown, a government offi

Kenya, became so enchanted with
question of flamingo behavior that
six years he spent every nonwork-
moment following them to the alka-
lakes of Kenya and Tanganyika,
ng a small plane when necessary to
ch them in their most inaccessible
eding and feeding grounds. The
ılt of his work is *The Mystery of the*
mingos, which is illustrated with
nerous black-and-white photographs
ndon: Country Life, Ltd., 1959).
et Kear and Nicole Duplaix-Hall are
editors of *Flamingos*, a collection of
cles resulting from the International
mingo Symposium held in Slim-
lge, England, in 1973. This sym-
ium, sponsored by the International
ıncil for Bird Preservation, pro-
ed information on the conservation,
logy, physiology, captivity, and
onomy of the flamingo. The volume
excellent photographs, maps, and
eral pages of bibliography (Berkham-
: T. and A. D. Poyser, Ltd., 1975).
wo *National Geographic* articles,
ı pictorial supplements, provide in-
nation about flamingos: "East
ca's Majestic Flamingos," by
Philip Kahl (February 1970, pp.
-94) and "In Quest of the Rarest
ningo," by William G. Conway
y 1961, pp. 90–105).

Wolves (p. 80)
the howl of the wolf should some
be stilled forever, it will still be pos-
to hear it in a 1971 recording by
ımbia (#C 30769) of *The Language*
Music of the Wolves, narrated by
ert Redford with slipcase notes by
rles Burr. Ronald M. Nowak's arti-
for *Natural History* ("The Mys-
us Wolf of the South," January
) detailed work being done to pre-
the extinction of the red wolf.
e specific is the chapter, "Status of
Red Wolf in the United States," by
. Riley and R. T. McBride, in *The*
Canids: Their Systematics, Be-
oral Ecology, and Evolution, edited
Michael W. Fox (New York: Van
rand Reinhold Co., 1975, $19.95).
/ and McBride describe steps taken
ıe federal government in the early
s to protect the red wolf and its
s at that time.
David Mech's standard reference
, *The Wolf: The Ecology and Be-*
r of an Endangered Species (Gar-
City: Natural History Press, 1970,
), includes a section on the history
e understanding of red wolf/coyote
idization. Also addressed is the
em of the identification of the red
as a separate species.

Pamela Haas

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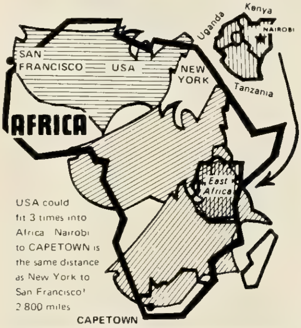

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Announcements

We've Been Here 100 Years, a photography exhibit to commemorate the hundredth anniversary of the Museum will open December 8 in the Hall of Northwest Coast Indians on the first floor of the Museum. The photographs will depict the bustle of opening day on December 22, 1877, as well as the farms, tenements, and stores that surrounded the original Museum building. The exhibit will run through January.

The traditional pre-Hispanic **Music of the Andes** will be performed in the Museum's auditorium at 3:00 P.M. on Sunday, December 4, by Tahuantinsuyo, a musical group consisting of Pepe Santana of Ecuador, Guillermo Guerrero of Peru, and Jorge Link of Argentina. The group, which uses more than fourteen traditional instruments of the South American highlands, also performed in the Museum during the "Songs for a Summer Night" in August. This concert is free to those who have paid the Museum entrance fee.

The Roosevelt Rotunda will be a child's wonderland until January 6 as hundreds of origami animals, plants, and even minerals shimmer on the Museum's twenty-five-foot artificial **Christmas Tree.** Every year for the past five years, Museum volunteers have added to the collection of traditional Japanese folded-paper ornaments, until now there are 1,500—including pandas, crabs, spiders, reptiles, squirrels, and even a dog complete with fleas! A dove of peace will crown the tree and, adding to the magic, a giant mobile depicting the sun, moon, and stars will be suspended f the ceiling.

The December event of month, **Azurite and Gold Cryst** will go on display in the Roose Rotunda, beginning December The exhibit, on loan from the N mont Mining Corporation, inclu a matrix specimen of azurite c tals of unsurpassed quality. Val at $250,000, it was unearthed Tsumeb, South-West Africa in 1 where, it is rumored, a mi traded it to a hotel keeper to off a small debt. The Newm Mining Corporation recognized value, however, and arranged its recovery. Another feature of display will be a large specime crystalized gold, also valued $250,000, which was taken fro mud-filled fissure at Empire Mine in Grass Valley, Califor

Peru's Golden Treasures, largest exhibit of Peruvian ever to appear in this country remain on display through Janu 1, 1978, in Gallery 77 on the floor of the Museum.

The Museum's new **Hall of tiles and Amphibians,** one of world's most complete exhibit these animals, opened on Fri November 18. The hall is loc on the third floor of the Muse

The **Ballad of the Bremen Ban** light opera for children under will be performed by the Caran Center for Music and the Arts, cember 27 to 30 at 11:00, 1:30, 3:00 in the Museum's auditori Admission is free to those have paid the Museum entrance

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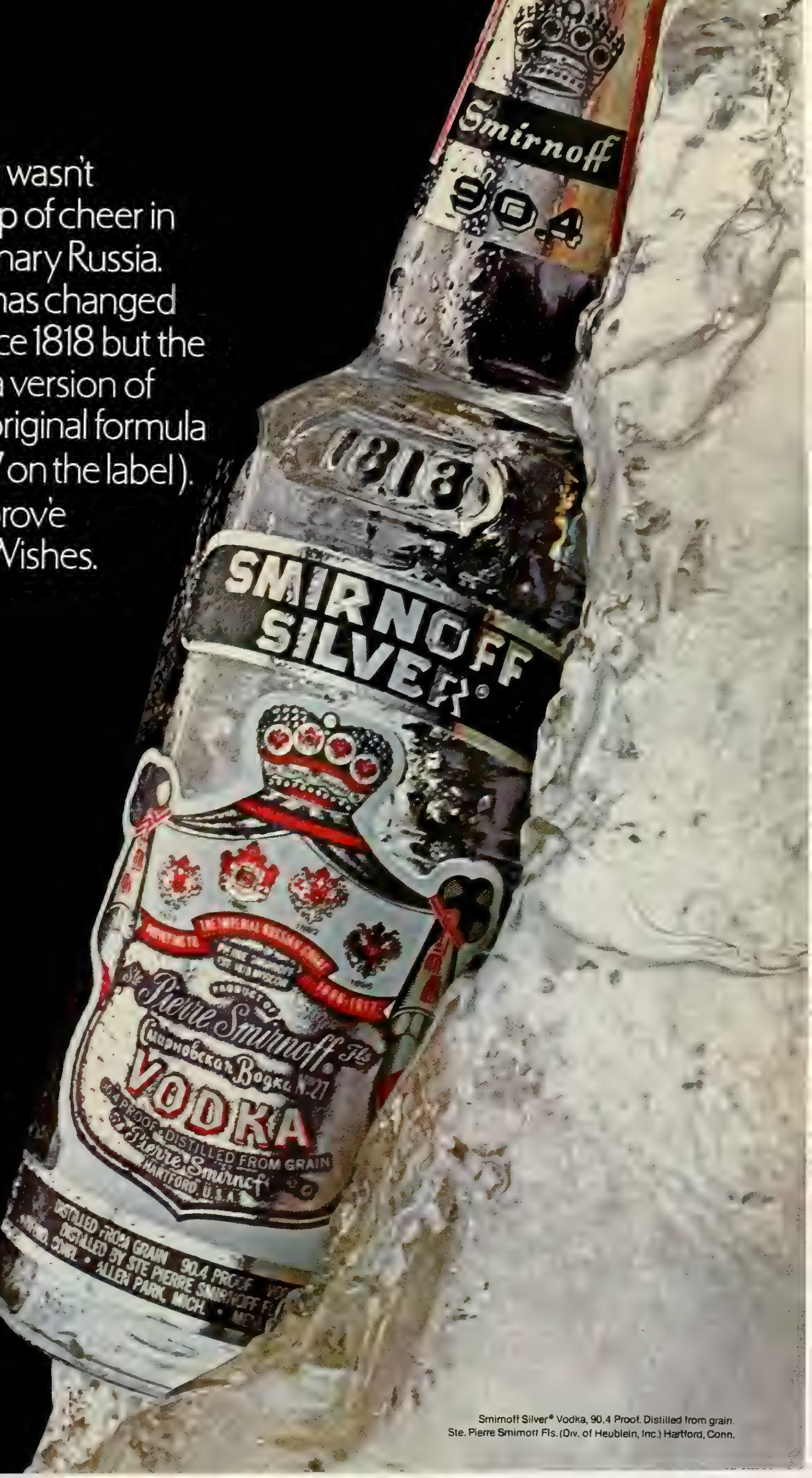
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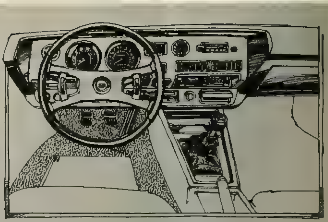
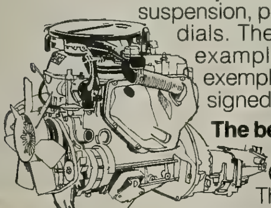
THE 1980's CELICA

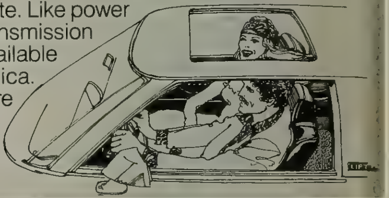


The new Toyota Celica. It's here now. A car which meets or exceeds all 1980 Federal fuel economy and safety standards. The latest in Toyota engineering advancements and wind tunnel refinements have produced an aerodynamic work of art. The Celica GT Liftback (pictured), GT and ST Sport Coupes.



A beautiful car and a fine machine. The GT Liftback aerodynamics have contributed to increased interior room (4″ at shoulders), stability, acceleration and efficiency. The handling formula includes MacPherson strut front suspension, power assisted front disc brakes, and steel belted radials. The Celica's cockpit instrumentation is a beautiful example of functional engineering. And comfort is exemplified by the reclining bucket seats with newly designed adjustable driver's seat lumbar support.

The beauty is value. The 1978 Celica GT Liftback delivers Toyota dependability and economy. In EPA tests the Celica GT Liftback was rated at 34 highway, 20 city. These EPA ratings are estimates. Your mileage will vary depending on your driving habits and your car's condition and equipment. California ratings will be lower. GT Liftback options are for personal taste. Like power steering, automatic transmission or the new sun roof (available Jan. 1978). The 1978 Celica. The car of the 80's here today.



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